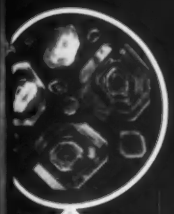
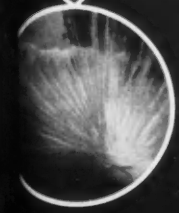
CHEMISTRY





NOVEMBER
1958

LATEX WONDERS – Dr. Ryden's Remarkable Billiard Balls

50¢

A SCIENCE SERVICE PUBLICATION

Chemistry as a Liberal Education

➤ CHEMISTS are sometimes taken to task as not sufficiently interested in what our friends in the humanities, social science, languages and related fields call a "liberal education."

Let us agree at once with these critics, whether their premises are correct or not, that a broad, inclusive educational experience is desirable — even essential in this fast-moving world. We may quarrel with those who insist that everyone should take years of Latin, for we may argue that Russian would be much more practical and give the same kind of mental drill in irregularities and memory as the "dead" language that was so antecedent to the modern romance languages. But the problem is not Latin.

It is those who do not feel that science is part of a liberal education that we are worried about. It is just as illogical and discouraging for our good friends in other disciplines to not recognize the need for non-science specialists to know at least a little about science as it is for the few rigorous science zealots to oppose broad education for science specialists.

Everyone, including politicians, ministers, lawyers and business men, should know the elementary facts about the way that the world is put together. That means knowing something about chemistry, just as all should know simple facts of everyday law.

Everyone should know that there are atoms, molecules, and elements. They should know how steel is made, where sulfur comes from, the marvelous development and usefulness of organic chemicals and that there are plastics and how they are made and used. The simplest chemical principles and materials should be familiar to those who work in kitchens and home workshops.

Like reading, writing and arithmetic, such knowledge should be assimilated in the years of growing up, through their incorporation in the basic schooling of all children.

CHEMISTRY

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Latex is the sticky white fluid found in dandelions, but a persistent scientist has synthesized it and developed applications from paints to microscopic measurement.

Dr. Ryden's Remarkable Billiard Balls

by WILBUR CROSS

➤ A FEW MONTHS ago, in Dearborn, Michigan, the automotive industry saw the inauguration of one of the most significant developments in its history: the dunking of Lincoln and Ford bodies into 9000-gallon dip tanks of a latex-base, water-thinned paint. The two factors of significance to the industry are, first, that this paint actually gives better first-coat protection against corrosion and rust than the sprayed-on paints they had used in the past and, second, that it is completely nonflammable during application.

It is conservatively estimated that latex paint will save automobile manufacturers millions of dollars in fire damage and thousands of man hours, as well as prevent innumerable injuries and deaths, by cutting down the disastrous paint fires which have plagued auto-makers for years.

The story of latex paint, one of the most remarkable developments in the history of the paint industry, goes back to 1937 and another city in Michigan: Midland. That year, Laurence ("Zip") Ryden joined the research staff of the Dow Chemical Company. Since he was only 29 and not long out of the University of Illinois, where he had received his doctorate, he was assigned to a job not much relished by some of the more experienced scientists—latex research. Latex, a sticky, usually white fluid, is found in many places in nature, commonly in dandelions or milkweed.

Man-made latexes, produced by emulsifying various chemicals in formulation with water, were at that time the ugly ducklings of chemistry. Manufacturing them as substitutes for natural rubber had been tried, but this did nothing for the manufacturers except generate complaints. In bathing suits, it ripped at embarrassing moments; in girdles, it failed to retain its elasticity; in raincoats, it became brittle during cool weather.

As World War II approached, Dr. Zip Ryden could have transferred to more exciting fields, but something about latex fascinated him. Latex in appearance under the microscope is nothing more than a mass of what scientists at Midland referred to as minute white "billiard balls" — remarkably uniform in structure, each less than a half micron in size. Yet despite its apparent simplicity, latex

was infinitely complex, giving rise to endless questions. Why was it rubbery under certain conditions, brittle under others? Why did it refuse, on the other hand, to dissolve or change its shape when subjected to solvents, heat and other external forces which should have reacted quickly? Why were the microscopic particles so remarkably uniform in structure regardless of origin?

As America swung into second gear during the early war years latex had its moment of glory. Our supplies of rubber were suddenly sheared off in the Far East, while our need for them was more voracious than ever — for tires on planes and military vehicles, for gaskets in engines and sealers in weapons, for countless uses in electronic equipment and electrical insulation. Latex and other synthetics went to war as substitutes.

Meanwhile Dr. Ryden, a man with remarkable enthusiasm and persistence, studied latex for eight years, seeking uses for it — without much success. Time after time, colleagues would ask, "Just *what* is it you are looking for, Zip?"

Always he would reply quietly, with an answer that came to be his byword, "I can't describe it, but I'll know it when I see it."

For a time, Ryden experimented with latex as a coating to preserve fruits and vegetables in shipment. The idea was sound, but the latex proved to have such a non-appetizing odor that no shipper would touch it. Then one day in 1945 he heard about German experiments with paint substitutes during the war. One product, a crude latex, had been mildly successful when used in interiors. Paint! Could that be what Ryden was looking for? Other men had had the same idea, but most envisioned latex paint as another substitute while oils and solvents were still in short supply.

Ryden's early paint formulations had several major disadvantages. The paint had a persistently unpleasant odor, and it refused to brush on easily or smoothly. It had to be mixed constantly during application and even then went on as awkwardly as though it were library paste. Many experts in the industry were convinced that Dow — and especially Ryden — was wasting time trying to invent a new type of paint. But time after time Ryden, with characteristic faith and enthusiasm, tried new formulas, and each trial brought him closer to success, but he was still faced with two persistent problems: *odor* and *instability* (the tendency of the paint to become lumpy during storage, shipment or temperature change and form "fish eyes" when brushed on a wall).

Ryden decided that his biggest problem was to overcome instability. It looked as though he would never solve it when, in August, 1949, he was so seriously stricken with polio he was given little chance to recover.

Colleagues were therefore surprised, a few months later, to learn that Zip was again pursuing the secrets of latex. Though flat on his back in an iron lung, he was dictating experiments for his staff to try in the lab.

It was no lucky accident that finally resulted in a breakthrough. With his keen mind clicking away like a tabulating machine, Ryden had ruled out one unsuccessful approach after another. Now he began thinking in terms of a group of solutions known

as "stabilizers," whose primary purpose was to prevent molecules in a solution from sticking to each other — yet they had to retain a *uniform attraction* for each other in order to form a tough coat when brushed on a surface.

The answer finally came with a chemical similar to the synthetic detergents commonly used for home washing machines. Each particle of a detergent acts like a microscopic magnet, one end attracted to grease and dirt, the other to water, in this manner drawing the grime out of fabrics into the water. The detergent Ryden finally arrived at for his paint, was attracted to the latex "billiard ball" at one end of the molecule and to water at the other. Thus, the natural tendency of the water (used to thin the paint) to form a *film* rather than a lump attracted the latex particles to follow suit. And, as Ryden had hoped, the detergent had no smell and left him with an odorless paint.

Unheard of by consumers only ten years ago, latex paints are now being manufactured at the rate of 60 million gallons a year. According to the National Paint, Varnish and Lacquer Association, they are the main reason why amateurs today do 71 percent of all the indoor, and 47 percent of all the outdoor, painting on homes— and why approximately one-third of these non-professional painters are women. Why?

The latex paints are easy to apply with brush, roller or spray, have low odor and no toxicity, and generally dry to the touch within 30 minutes or less. Most latex paints are self-priming and will go on directly over newly dry plaster, cement, stucco and other lime-containing materials, whereas older types of paint would require some sort of sealing coat first to prevent adverse chemical reaction. Since latex paints are water thinnable, the matter of cleaning up brushes, drippings and your own skin is a simple process of using a damp cloth or a little soap and water.

When dry, the latex paints have excellent color fastness, won't blister or peel easily, and can be quickly cleaned of substances that often raise havoc with other types of paint — like crayons, grease, ink, or even caustic household chemicals. Furthermore, they can be applied over other flat paints, either oil base or alkyd, and over enamels that have been sandpapered, but should not be used on raw wood because the water they contain raises the grain; a wood sealer should be applied first.

You cannot as yet use latexes for all purposes, but the limitations are vanishing. For example, there never used to be any types except flat (dull) or semi-gloss on the market, but manufacturers have now developed a high-gloss latex paint, and new types of exterior latex paints for use on masonry and on properly primed metal and wood. Though these have limitations, they also have advantages in that they can be applied on damp surfaces in damp weather, and a second coat can be applied a few hours after the first.

Latex paints have what one manufacturer refers to as "friendly" properties. One of these is the way they "breathe." Two comparable homes next to each other were selected for the test. The roof of one was painted with a latex paint; the other was not.

Hourly interior temperatures were recorded, some showing the space under the painted roof to be as much as 20 degrees cooler. What had happened was this: during the day, the paint helped reflect the sun's rays. Yet, at the same time, the tiny "billiard balls" of latex retained millions of pores through which normal household heat and vapors could escape. Why, then, doesn't the paint let rain seep through? Because the helpful little molecules expand when water strikes them, pressing against each other in a honeycomb pattern (the same effect as squeezing several small rubber balls together) to form a water-repelling barrier.

This breathing process can be important in the walls of your house, since imprisoned moisture can rot timbers, crumble masonry, corrode metal. A good latex paint will perform the dual function of keeping rain out, yet permit captive vapors to escape before they condense into moisture.

One curious and significant use which is now made of Ryden's microscopic billard balls has nothing to do with paint. Several years ago two scientists at the University of Michigan by coincidence learned about the uniformity of latex particles. Drs. Robert Backus and Robley Williams found that by placing minute quantities in slides under a powerful electron microscope, they could use them as infinitesimal (there are 2.4 billion in a single drop) "rulers" to measure and count viruses and bacteria so small that their size or weight had never before been computed.

This added greatly to medical science's fundamental knowledge of viruses, and thus was a vital step forward in the conquest of disease. But, ironically, Ryden was never to see the full humanitarian contributions of the product that he, perhaps more than any other man, had been responsible for developing. In 1954, working persistently to the very end, he died of an infection resulting from his battle with polio.

Our world is infinitely better and brighter, however, because one man kept saying over and over, as he labored long hours at research, "I can't describe it, but I'll know it when I see it."*

*On the Back Cover

➤ A DILUTE DROP *of latex, with less than 1% solids, looks like this when enlarged about 3000 diameters microphotographically. The little spheres of polymer are suspended in water. These particles are extremely uniform in size and, when free as they are in the undried portion (right), they dance erratically at a high rate of speed due to Brownian movement. The crystallization of particles at the edge in a hexagonal arrangement is due to rapid drying of the latex paint. Actual paint film on a house wall would be several layers thick. Each particle is about 0.00005 inch (5/100,000ths) in diameter, and an average particle in popular paint latexes contains 30,000 molecules.*

This article is published in cooperation with READER'S DIGEST

The Electrochemical Society

Another in CHEMISTRY's Series on Professional Organizations

➤ The Electrochemical Society was organized in 1902 by a group of industrial and academic men who felt that there should be more communication between people who were engaged in various phases of electrochemical practice, such as electric furnace or electrolytic manufacture of chemicals, electroplaters, and teachers of electrochemistry.

The Society has now grown to international proportions, with a membership of about 3,000. It holds annual spring and fall meetings in various United States and Canadian cities, and publishes a monthly *Journal* which contains about 1,000 pages per year of technical papers, in addition to Society news, book reviews and other material.

There are nine major divisions for members of diversified interests: Battery, Corrosion, Electric Insulation, Electrodeposition, Electronics, Electro-Organic, Electrothermics and Metallurgy, Industrial Electrolytic, and Theoretical Electrochemistry. Each division arranges its programs for the annual meetings, at which research workers present papers which have been or will be submitted for publication. Sometimes special symposia are held and the papers presented are published in book form, for the ECS Monograph series. The Society and its divisions also maintain up-to-date reference books in certain fields, for example "Modern Electroplating" and "The Corrosion Handbook."

In addition to the divisions, there are numerous local sections of the Society with headquarters wherever enough members can hold frequent meetings; there is even an active Section in India, which publishes its own bulletin. At the local meetings, the speakers are usually active research men who discuss current developments in their own fields.

Students between the ages of 18 and 29 may become Student Associate Members at about one-fifth the usual fee. They receive the *Journal* and can register at the annual meetings at a reduced rate. Active members must be at least 25, have a degree with a major in some natural science, and have additional experience which establishes an interest in electrochemistry. The Society has several hundred sustaining and patron members among industrial firms, who thus help with financial support.

The Society makes two major awards, in alternate years, to outstanding electrochemists: the Edward Goodrich Acheson Award, which was established in honor of the famous inventor of electric furnace methods of making graphite and carborundum; and the Palladium Medal Award, made possible by royalties from sales of the Corrosion Handbook and a magnificent gift of palladium metal, from which the actual medals are cast. In addition, the Society with its divisions and local sections honor outstanding work in various fields with a number of other prizes and awards.

Society Headquarters are at 1860 Broadway, New York 23, N. Y., and information concerning its activities may be obtained by writing to the executive secretary at that address.

Breath of Life for Defense

Oxygen Most Important Chemical in a Nation's Arsenal. Man Has Improved on Nature by Concentrating and Collecting Oxygen as LOX, Its Liquid Form.

➤ THE AIR we breathe is today the most important single chemical used by industry and in national defense.

Just as most of nature's own important chemical reactions involve the combination of substances with oxygen from the air, the push for a guided missile, the conversion of iron to high grade steel, the creation of an explosion, the conversion of otherwise useless gases and liquids to valuable materials, all depend on a combination of substances with oxygen.

Oxidation processes in nature generally are slow. However, scientists believe that when the earth was in its earliest days and abounded with many highly reactive chemicals that today are found only in laboratories, reactions between these elements of the earth's crust and oxygen of the atmosphere took place rapidly, with the liberation of heat and light in the form of "combustion."

Today we deliberately foster combustion between gasoline and oxygen in the automobile engine and between alcohol or other fuels and oxygen in the rocket engine. The energy thus liberated is put to work for us.

In many important oxidation processes we steal a march on nature by concentrating our oxygen as the pure element, undiluted by nitrogen and inert gases of the atmosphere, for more efficient use.

Sometimes it is compressed in steel cylinders — familiar red or green "bottles" found in hospitals and some factories.

The trend in industry now, however, is to store the greatest amount of oxygen in the smallest space by compressing and cooling it until it becomes a liquid.

Liquid oxygen used at steel mills and in chemical processing is the same famous LOX found near many missile launching sites.

It is easy to see why industry and the armed forces are devoting millions of dollars and countless hours of scientists' time to develop increasingly better facilities and techniques for producing oxygen as a liquid. To store or ship one pound of the gas compressed at a pressure of 2,400 pounds per square inch requires a container weighing over five pounds. However, the same one pound of oxygen stored or shipped as a liquid needs a container weighing only about three-quarters of a pound.

Besides the saving in container weight, liquid oxygen also saves considerable space as contrasted to gaseous oxygen. A container of a given size will hold 800 times as much oxygen in liquid form as in gaseous form.

However, the picture is not necessarily all rosy in favor of liquid oxygen. Since the liquid boils at 297 degrees below zero, Fahrenheit, it must be shipped in a constantly refrigerated container called a Dewar flask. These, on a larger scale, are

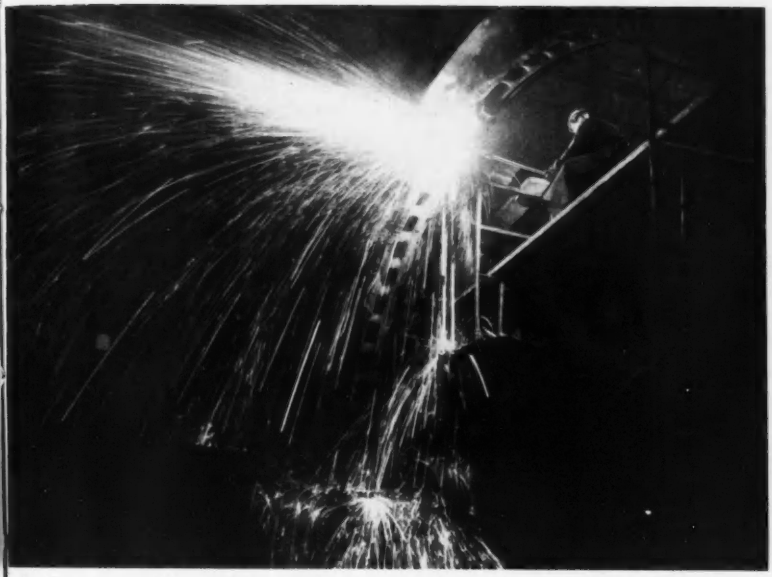
about the same thing as the common vacuum bottles sold under the trade name of Thermos flask.

Because liquid oxygen always wants to expand to 800 times its liquid volume, pipelines and pumps used to transfer LOX from storage to its point of use must be capable of withstanding very high pressures as the oxygen "warms" up to its sub-zero boiling point.

The chief interest in liquefying oxygen, of course, is to facilitate its storage and transportation. With the exception of a very small quantity used in low-temperature laboratory experiments, oxygen is used as a gas. However, in most operations it becomes gaseous only in the last instant before use.

Oxygen, whether stored as a liquid or as a gas, has hundreds of important uses in national defense and commerce. Chief among them is its role as the more important half of the oxygen-acetylene torch used in welding metal together and cutting it apart. Many fuels besides acetylene can be used in the torch, but oxygen almost always is present on the team.

Quantities of oxygen are consumed each year in the production of synthetic sapphires for industry. Oxygen is used in preparation of hydrogen



➤ OXYGEN AT WORK. *Not so glamorous as its use in guided missiles, nor so colorful as its place in modern steelmaking, oxygen finds its biggest role in the oxygen-acetylene blowtorch used either for welding metal together or cutting it apart.* —Air Reduction Co. photograph.

peroxide, important today for "false" blondes and flying bombs. Some processes for manufacturing ammonia, ethylene for plastics and other important "starting-point" chemicals depend upon oxygen.

One of the fastest growing uses for oxygen is in the processing of steel by the comparatively recent oxygen converter process.

The oxygen converter makes high-quality, low-carbon steel as rapidly and as economically as the Bessemer process does. In addition, the oxygen converter offers the quality of steel that is produced by the open hearth process.

This new technique of steelmaking that, although accountable for only a small portion of the steel produced in the U. S., is rapidly coming into favor was developed in Europe. Its fundamental difference from the Bessemer converter process is that a jet of pure oxygen is blown directly down on the molten charge of iron to literally "burn out" carbon and other impurities. In the Bessemer process, a stream of ordinary air is blown up through the iron bath.

The producing, cutting and welding of iron and steel is the chief use of compressed or liquid oxygen today in the U. S., but the most glamorous use by far is in missles.

Whereas air-breathing engines, as their name implies, draw oxygen for combustion from atmospheric air, rocket engines operating far above our normal atmosphere must carry their own oxygen with them. Even rocket engines designed for use at low altitudes carry concentrated oxygen for performances far superior than could be expected with oxygen as it appears diluted in ordinary air.

In the missile field and some industrial operations oxygen has become so important that it is produced, or separated from the atmosphere, at the launching site or industrial plant rather than being shipped from an air-reducing facility.

For example, Air Reduction Company, Inc., New York, is building a new 120-ton-per-day oxygen facility at Armco Steel Corporation's new Butler, Pa., plant to provide the vast amount of high purity oxygen needed for that operation. It would be too costly, time-consuming and almost foolhardy to ship such vast quantities of oxygen long distances from production centers when it is easier to build a plant adjacent to the factory that will be using the output.

Oxygen's supremacy in the chemical industry has not been without a struggle against older — "traditional" — ways of doing things. And, it appears its supremacy could just as easily be lost as oxygen in turn bows to further progress.

In the missile field, as an example, some more powerful or easier-to-handle oxidizing agents than oxygen itself are being developed. "Oxidizing agent" and "oxidation" are terms arisen from the early days of chemistry which now describe a type of electron transfer to certain chemical reactions. Fluorine is representative of several much more powerful oxidizing agents that may see wide use in missiles.

Nitrogen tetroxide is another bidder to replace LOX in rockets. It is easier to handle, requires no refrigeration and reacts spontaneously upon contact with many fuels.

Canned Food Research

Three Unusual Food Research Laboratories Supported by Nearly All Processors of Pre-Cooked Canned Foods for the Table Strive to Make Canned Foods Even Better, Less Expensive.

➤ Do CANNED FOODS taste better after they have been stored on the pantry shelf or after storage in a refrigerator? How tightly should asparagus be packed in a can to allow the canner to use the most efficient cooking process and assure the consumer the best product at the lowest price possible?

Are there any ill effects caused by leaving left-over canned foods in the can instead of transferring them to dishes before returning them to the refrigerator?

These and literally hundreds of other questions important to the health of families and the quality, taste and price of canned foods have been answered, or are in the process of being answered, by 36 chemists, bacteriologists, food technologists, sanitation engineers and other scientists in three of the nation's best equipped and best staffed laboratories.

The answers are ferreted out by the hard-working men and women in the laboratories, pilot plant and test kitchen of the National Canners Association, the trade group that represents most of America's packers of pre-cooked canned, jarred and bottled foods designed for human consumption.

Among the Largest

Of the 12,000 U. S. trade associations recognized by the Department of Commerce, the National Canners Association has one of the largest staffs. The majority of home office and field workers, those employees working directly for NCA headquarters, devote their time and efforts to "service-type" work, much of which is research of one type or another.

Forty-six people, including secretaries and bookkeepers, staff the laboratories in Washington, D.C., Berkeley, Calif., and Seattle, Wash.

Some of them are engaged in detailed inspections of canneries, at the owners' requests, to help improve sanitation, get rid of waste products without offending the surrounding community, to make processes more efficient and cheaper.

NCA also encourages research on the raw foods used in canning. Field workers even go back to the seed itself in helping canners provide the public tastier foods at lower costs.

They help farmers pick the best seeds or plants to produce foods with desirable canning characteristics. Not just any carrot or bean is suitable for canning. High quality in raw products is essential to a canner's operation. The foods used have been either specially grown for canning, or they have been critically selected by canners' representatives.

The nation's canners, through their own laboratories or through Federal and state experiment stations, have developed special cannery strains and varieties of peas, beans and tomatoes that resist wilt.

New types of fungicides and insecticides for the control of diseases

and insects are constantly being introduced. In this connection, also, the chemistry group in NCA's laboratories conducts a continuing search for reliable and easy-to-use tests for insecticides remaining on fruits and vegetables after washing.

Canners have established scientific controls over fruit ripening. They even have developed a technique for predicting fairly accurately the best harvesting dates for peas and corn to assure picking at the ideal stage of maturity. The method involves totaling the "units of heat" received by plants growing in a certain area. Published data permit farmers to stagger planting dates so that ideal harvest times also will be staggered.

Since canning of foods is still largely at the mercy of mother nature and her growing seasons, the industry itself is highly seasonal. Many non-canning industries that operate near capacity the year around can ease their wastes — and the wastes may be few in many industries — into streams and rivers over an extended period without "dumping" an excessive amount at any one time.

"Garbage Chemistry"

Anyone who has ever prepared foods for storage is aware of the high proportion of waste that must go down the drain or into the garbage can — inedible stems, leaves, roots, scrapings, wash water, excess cooking water, etc. Imagine the public relations problem of a large cannery that must make this disposal practically all at one time, shortly after the harvest season!

The easiest way to get rid of wastes is simply to pipe them to the nearest stream or river. However, this not only cannot be done under many local laws, but no canner would care to face the resulting ill will of the downstream populace.

The disposal technique most used by canners is called "lagooning," and consists of running wastes into giant ponds where they oxidize, or decay, to a point where they may be run into rivers, sometimes after further treatment. Many variations of "lagooning," as well as other techniques, have been studied by NCA engineers. The laboratories have developed tests that enable cannery personnel to measure the pollutional strength of wastes.

Radiation Sterilization

Not all of the National Canners Association's research is done in its own laboratories. On some occasions the NCA and its members feel a need for research that can be handled better under contract to an outside laboratory already experienced in and equipped for the work.

On the other hand, NCA's scientists take on considerable work submitted by other groups. Of course such work must pertain to canning and the results must be available for use by the industry.

NCA is assisting the Army Quartermaster Corps in studies on foods sterilized by radiation rather than heat. Under NCA rules, members must be firms that pack food for human consumption into air-tight containers ("cans," which may be either metal or glass) and sterilize it by heat cooking. Radiation, or "cold sterilization," would be a technical advance of keen interest to NCA members.

Another example of outside work

done cooperatively by NCA scientists is the taste-test series conducted for a Rutgers University group. Prof. C. Olin Ball, Rutgers research specialist, is trying to determine whether there is a difference in taste between canned foods that have been stored at room temperature and those that have been stored in cooler surroundings.

NCA's District of Columbia laboratory staff has been administering taste panel tests on the two types of samples. Prof. Ball's research is expected to be published in technical journals.

And, what about packing asparagus?

NCA's food processing group has devised an easy-to-apply rule of thumb that lets canners know how tightly to pack asparagus spears for most efficient cooking: when cans of uncooked spears are inverted without shaking, all spears should slip out of the can together to a distance which exposes most of their length; giant and colossal sizes should fall this distance in about one second and other sizes may slip out with a slight drag within about six seconds.

Will It Spoil?

Perhaps the question most frequently asked by the housewife is, "can I safely store foods in cans that have been opened?"

The answer, NCA laboratories report, is that foods may be stored safely in opened cans, provided they receive the same proper refrigeration (where refrigeration is called for) as they would receive if transferred to a dish or bottle. However, after a period of time that varies with different foods and conditions, some acid foods left in the opened can may acquire a "metallic" or "off" taste, and the can may display a dark line of de-tinned area where the food and air meet. These are harmless.

A New Look at Chlorophyll

▶ Chlorophyll, the substance that is responsible for sustaining all life, may prove to be life-saving.

Two classes of chlorophyll compounds, chlorins and rhodins, have been shown to have a beneficial effect on laboratory animals with induced heart failure.

Their effect on heart disease, demonstrated many times on the hearts of frogs, rats, rabbits and dogs, has been reported to the American Chemical Society by Drs. Herbert Wetherell, Jr., M. J. Hendrickson and A. R. McIntyre of the University of Nebraska College of Medicine.

The materials are not ready for testing on human beings, although the activity of chlorophyll derivatives on the heart has been studied for some time.

"Digitalis, which is the drug used in heart failure," Dr. Wetherell explained, "is very satisfactory, but it must be handled with caution because of its toxic properties. Our substances appear to be relatively non-toxic, and to have them available as supplements to digitalis would be advantageous.

"We do not wish to imply that eating large quantities of vegetables rich in chlorophyll, such as spinach and beet greens, is good for one's heart. The materials we have studied are derived from chlorophyll which has been subjected to several complicated laboratory procedures."

New Chemical Patents

To obtain copies of these new patents, order them by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents in coin, money order or Patent Office Coupons (but not stamps) for each patent ordered.

Elemental Boron

➤ A CHEAPER, easier and safer method for the electrochemical production of elemental boron has been found. It involves the use of sodium, heretofore thought to make the preparation of boron commercially impractical.

Nelson F. Murphy and Richard S. Tinsley of Blacksburg, Va., claim they have found that when alkali metal oxides are used for preparing boron from boron compounds either sodium or potassium can be used with equal effectiveness. Sodium and its compounds are more plentiful, less expensive and less reactive than potassium and its compounds.

The invention, state the inventors, is based upon their discovery that a mixture of boric oxide and an alkali metal fluoborate containing a substantial amount of an alkali metal oxide will produce good yields of elemental boron when electrolyzed at a temperature of from 750 to 875 degrees Centigrade.

Although boron compounds are currently finding wide use in rocket fuels the same is not true for boron itself. However, pure boron is used in a number of processes and its study will add to man's knowledge of rocket fuels.

The inventors, who won patent No. 2,848,396, assigned the patent rights to the Callery Chemical Company of Pittsburgh, Pa.

Rocket Fuel Fireworks

➤ SOLID ROCKET and missile fuels, long used by the military in secret applications, have entered the fireworks industry. A "pyrotechnic mass," or firework composition, cast in solid plastic and relatively insensitive to shock and friction, has been awarded a U. S. Government patent. The inventor is Ronald Gibson Hall, Hemel Hempstead, England, who has assigned rights in his patent to Brock's Crystal Palace Fireworks Ltd., a British company.

The heart of Mr. Hall's invention consists of "an intimate mixture" of a formaldehyde resin, an oxidizing agent, together with other pyrotechnic materials, and a catalyst, or setting agent.

The result is a hard, plastic mass with embedded fuse, which the inventor claims is so stable that it does not even require strong enclosure in a case, as do powder fireworks. In addition, Mr. Hall's product is "not liable to be shaken loose from the finished articles by normal or even careless handling." Consequent danger of premature explosion is avoided.

Burning time of the product is varied by varying the type and quantity of oxidizing agent used, and even burning is promoted by the use of substances such as lamp black. Other chemicals may be added to the mixture to produce colored fire, colored

smoke, "sparklers," and other effects. Insensitive organic nitro compounds are added to make the product suitable as rocket fuel. If desired, volatile compounds may also be incorporated to provide insecticidal smoke.

For his invention, Mr. Hall received patent No. 2,841,481.

Rocket with Unique Fuel

➤ A TINY lightweight military rocket with a unique solid fuel arrangement has won a patent for a Princeton, N. J., inventor.

Only nine and a half inches long from warhead to exhaust nozzle, the weapon may be constructed of plastic or glass. Bars of solid propellant, arranged around the inner circumference and extending nearly the full length of the rocket shell, give the missile a smooth constant thrust. Fully fueled, it can weigh as little as three ounces.

The inventor, Alfred C. Loedding, says that the rocket's high speed, more than a mile per second, and great striking force make it a potent infantry and fighter plane weapon.

The fuel bars, he claims, are easy to manufacture and install, and may be quickly ignited. By using a strip of fast-burning gauze impregnated with the same type of powder making up the fuel, anywhere from one to more than a thousand rockets can be fired at once.

Mr. Loedding's patent, which has been assigned to the Unexcelled Chemical Corporation of New York, is No. 2,853,946.

Efficient Rocket Fuel

➤ ARNOLD L. AYERS of Idaho Falls, Idaho, and Cleveland R. Scott, Bartlesville, Okla., have earned a patent for their invention of "pure" rocket fuels. A "pure" rocket is described as a thrust producer which carries its own oxidizer and does not make use of the outside atmosphere.

The inventors' fuels are derived from diene compounds which are frequently used as bases for synthetic rubbers and plastics. They are also known as "hypergolic" fuels, in that they ignite spontaneously when brought in contact with an oxidizer, and do not require a spark, flame, shock, etc.

The inventors also claim a high efficiency for their fuels since they burn in actual operation just the way theory says they should on paper. This is not true of ordinary fuels, such as gasoline in an automobile engine.

Messrs. Ayers and Scott have been awarded patent No. 2,842,936, and have assigned the patent rights to Phillips Petroleum Company.

Patents Granted After 13 Years

➤ Two OF atomic energy's pioneers, both now dead, have received patents on some of their first inventions in the nuclear reactor field. The men, Enrico Fermi and Ernest O. Lawrence, applied for the patents about 13 years ago.

Dr. Fermi, a Nobel Prize winner in Physics, described his invention as "a novel means for improving the establishment of self-sustaining nuclear fission chain reactions."

The principal object, he said, "is to reduce the total danger sum of the impurities in a neutronic reactor by . . . eliminating atmospheric air therefrom. . ."

Dr. Fermi, Walter H. Zinn, Chicago, and Herbert L. Anderson, Hartford, Conn., were awarded patent No.

2,852,461 which was assigned to the United States of America as represented by the United States Atomic Energy Commission. It was one of 1,088 patents awarded this week.

Dr. Lawrence, also a Nobel Prize winner in Physics, received two patents, one for an ion producing mechanism and the other for a calutron, a machine for production of isotopes such as uranium-235.

He received patent No. 2,852,689 for a mechanism which he claims: 1. is simple and rugged in construction, 2. provides calutrons with a uniform and copious supply of ions and 3. produces an ion beam more efficiently than ever before accomplished. For his new calutron Dr. Lawrence was awarded patent No. 2,852,690. This invention is intended as an improvement over earlier machines in space and material economies. Both patents have been assigned to the United States of America as represented by the United States Atomic Energy Commission.

Acid Growth Promoter

➤ GIBBERELLIC ACID, the agricultural wonder-chemical that promotes exceptional growth in plants, has earned a patent for Dr. Percy Wragg Brian, Margaret E. Radley, Philip J. Curtis and George W. Elson, all of Welwyn, England.

Gibberellic compounds were originally derived by the Japanese from the fungus Gibberella fujikuroi in the 1930's, and reported by them in Japanese journals. During World War II, little was known in the United States of the chemical, and Western scientists were concerned with scientific rumors of a Japanese "secret weapon" for increasing food production. After the war, British scientists began an intensive study of the compounds, and attempted to make a synthetic version.

An historic trade deal in 1955 was largely responsible for the introduction of the chemical into the United States. Dr. Brian, in this country for a visit, "swapped" five grams of gibberellic acid with Dr. John Mitchell of the Beltsville Station of the U. S. Department of Agriculture in return for a like amount of Amo-1618, a drug known to retard plant growth. At about the same time Dr. Brian made application for the current patent.

Although gibberellic acid is known to stimulate plant growth in concentrations as small as one or two parts per million of diluent, USDA scientists point out that much more research is necessary before the drug can be used effectively by the nation's farmers.

Dr. Brian and his colleagues have received patent No. 2,842,051, which they have assigned to Imperial Chemical Industries Limited of London, England.

Arsenic Tellurium Alloys

➤ IMPROVED crystal rectifiers which will find wide use in the communications field have been developed from arsenic tellurium alloys.

The rectifiers boast advantages over presently used devices such as germanium and silicon point contact rectifiers.

According to their inventor, Bernard Kopelman of Bayside, N. Y., crystal rectifiers are non-linear devices that have the property of transforming alternating current into direct current and are capable of handling fair-

ly broad frequencies of alternation of the source current.

Two fairly standard means have been developed for using such rectifiers; the application of an extremely fine point and the area type.

The arsenic tellurium alloy rectifiers overcome several disadvantages now present in other rectifiers. For one thing, they are much less costly to manufacture. Also, the arsenic tellurium alloys are useful both as point contact and area type rectifiers.

Crystal rectifiers made from the material under proper operating conditions, he notes, will stand exceptionally high operating voltages and high operating currents so that when properly used "they exhibit advantages over existing fixed rectifying devices."

Granted patent No. 2,829,321, Mr. Kopelman assigned the patent rights to Sylvania Electric Products, Inc., of Massachusetts.

2,4-D Weedkiller

➤ THE SCOURGE of poison ivy and wild honeysuckle, the weedkiller 2,4-D, has earned a patent for its inventors.

Dr. Waldo B. Ligett of Pontiac, Mich., and his colleague, Dr. Alfred J. Kolka of Clairton, Pa., have assigned to the Pittsburgh Coke and Chemical Co., Pittsburgh, Pa., their rights in patent No. 2,839,444, for a "Fungicidal Composition Comprising 2,4-dinitrofluorobenzene and Methods of Using Same."

The inventors point out that "organic fungicides have recently become increasingly important and have provided means for protecting material susceptible to attack by fungus organisms without resorting to the use of metallic compounds which have undesirable secondary properties. In particular, by the use of organic materials toxicity to mammals is largely reduced."

(The inventors refer to compounds of such metals as arsenic, antimony, and lead, which, though effective, are cumulative poisons, and extremely dangerous to have around the house.)

Buried in the patent is the paragraph: "In addition to fungicidal activity, we have determined that under some conditions of application and against some species, 2,4-dinitrofluorobenzene is an insecticide and a non-selective herbicide."

The use of 2,4-D as a weedkiller has proved to be its most important commercial application.

Metal-Loving Bacteria

➤ METAL-LOVING bacteria are being put to work by the Kennecott Copper Corporation extracting a variety of metals that would normally be lost as waste.

The bacteria, which live and breed in acid mine waters, have demonstrated that they are far better extractors of metals than processes presently used.

Kennecott scientists are currently tailor-breeding the bacteria for specific jobs. One strain of bacteria, for example, could not survive in solutions containing more than 150 parts of zinc per million. Successive breeding, however, has produced bacteria that can now thrive in a solution of 17,000 parts of zinc per million. The same tailoring has developed particular strains of the bacteria for aluminum, calcium, magnesium, manganese and molybdenum.

Historically, researchers have

known for some time that iron oxidizing, self-sustaining bacteria dwelled happily in the coal mine acid waters of the eastern United States. They knew too that these bacteria had the ability to oxidize ferrous iron to ferric iron at a rate considerably greater than would be due to the atmosphere alone.

The U. S. Bureau of Mines has reported that four of its laboratories are conducting small-scale research on the role of microbes in increasing metal production.

Now, a team of Kennecott scientists have received a patent on an invention employing the use of iron oxidizing bacteria in the cyclic leaching of sulfide minerals.

This was made possible when the team discovered similar strains of the bacteria present in eastern U. S. coal mine waters in acid mine waters in Utah and New Mexico.

Conventionally waste water from copper mines has been percolated and repercolated through ore waste dumps to leach out whatever copper values might be contained in the waste. With the bacteria inoculated into the ferric sulfate sulfuric acid leaching agent, however, the amount of copper recovered increases substantially.

The team points out that several factors need be considered in using bacteria to leach out metals from waste material. One factor, for example, is that redwood tanks, employed by many mining and milling operators, release a bactericide or bacteria killing agent. Bacteria, however, can be bred to tolerate this situation.

The scientists who invented the method are Stuart R. Zimmerley, Dean G. Wilson and John D. Prater of Salt Lake City, Utah. They assigned the patent rights of patent No. 2,829,964 to the Kennecott Copper Corporation of Salt Lake City.

Brain Chemical and Vitamin Deficiency

➤ A SIMPLE chemical compound that is found only in the brain and spinal cord is now suspected to be involved in the epileptic-like seizures associated with vitamin B-6 deficiency.

The chemical is gamma aminobutyric acid (GABA). Dr. Eugene Roberts, chairman of the department of biochemistry, City of Hope Medical Center, Duarte, Calif., established in 1950 that GABA is formed from glutamic acid. This is a chemical long thought to have a special role in brain function.

Subsequent work by Dr. Roberts has shown that a normal amount of GABA in the brain is dependent on the balance between its rate of formation and the rate at which it is used by nerve cells. A dietary deficiency of vitamin B-6, or a disturbance of the function of the vitamin in the body by chemicals, leads to a slower rate of formation of GABA and a consequent decreased amount in the brain, Dr. Roberts reported.

So far, various attempts have failed to increase GABA levels in the brains of normal laboratory animals by treatment with drugs, or by injection or feeding of the chemical. GABA does not appear to enter the brain readily from the blood stream.

GABA is unevenly distributed in various parts of the brain. There were ten-fold differences in the level of the chemical in different areas of the organ.

Light Bulbs Without Light

➤ EACH YEAR, here in the United States, more than three billion light bulbs (industry refers to them as lamps) are produced to help man to see. But few persons are aware that several million bulbs are produced which give no light at all or which are not used to see by.

In this strange group of intriguing bulbs and tubes lies an almost unknown story of lamps which have nothing to do with "seeing" but which are invaluable to man's welfare. According to Edward G. F. Arnott, director of research for the Westinghouse lamp division, these "dark" lamps perform such varied tasks as helping to take the toughness out of steaks, keeping food fresh, helping to capture criminals, detecting disease, and preventing it as well.

Other lamps will counteract bad odors, bleach fabrics, spur plant growth, make a picture "talk," help produce fertilizer, cure rickets, produce a sun tan, or perhaps merely save your life.

Ultraviolet Radiators

Among these weird bulbs is a rapidly enlarging group of lamps known as "ultraviolet radiators." These lamps emit an invisible kind of light. The vibrations they produce are so rapid and the wave length so short that the human eye cannot "tune in" on them. Included in this strange group are "black light" lamps. Most of these use mercury vapor and argon gas within a special glass tube or bulb. After all visible light has been filtered out or absorbed, the remaining ultraviolet radiation is capable of producing fluorescence or phosphorescence in certain substances — the fluorescent dyes of theatrical costumes like those we have seen at the Radio City Music Hall, or the brilliant fluorescing colors of advertising signs, or the magical brilliance of many cool, glowing minerals, gems, or paints.

This ghostly black light has been used to unveil the hidden beauty of mineral ores or a hundred varying kinds of modest fabrics, wall papers, plastics, or antique glassware, and black light is used to disclose scalp ringworm, to locate otherwise invisible cracks and flaws in metals, or to apprehend the criminal by reason of the fluorescing of finger markings, stains, or the otherwise invisible signs of erasures and forgeries. Sherlock Holmes could have used black light to establish who made a questionable sheet of paper, to reveal the source of the glass headlight of your automobile, or to determine where a diamond was mined!

Black light is carried into the wilderness in the search for tungsten or zinc or other mineral deposits. Fluorescent dyes are brilliantly visible, hence used to trace underground flows of water or to date a piece of petitpoint embroidery or an article of Sandwich glass, or to study antique furniture by reason of the fluorescence of glue. Black light establishes the time or place of paintings. It protects against fakes, and authenticates known genuine objects of art. It is a fairy wand in the hands of the modern detective-scientist.

Also in the ultraviolet group are those tremendously potent lamps,

sterilamps or germicidal units, which protect us against a myriad of diseases. Their invisible light destroys the germs in the air or else guarantees the purity of drugs and chemicals. Of the electronic tools placed in man's hands to prolong his life, ultraviolet lamps are among the most noteworthy.

A new ultraviolet lamp developed recently sets up a barrier of death to bacteria, virus, and molds. Placed in the home heating or air conditioning ducts, it affords protection to the entire family.

Radiation is produced which is about 100 to 1000 times more effective in killing micro-organisms than an equal amount of ultraviolet radiation from the sun.

Tests have shown this high-output lamp to be two and one-half times as potent as previous lamps of its size. It is particularly effective in killing the influenza virus. Tests have indicated that 80 per cent of air-borne virus and bacteria can be destroyed by inserting a single ultraviolet lamp in a heating or air conditioning duct.

At the new Duke University Hospital Wing in Durham, N. C., all of the ten new operating rooms, as well as the supply and surgical dressing rooms, are bathed in ultraviolet radiation. Dr. Deryl Hart, chief surgeon of the University, has found that these ultraviolet lamps reduced post-operative infections by 85 per cent, eliminated the occasional death from infection, reduced post-operative temperature, improved wound healing, lessened systemic reaction, and shortened convalescence.

At the present time, similar type ultraviolet lamps are being used by manufacturers of polio and Asian influenza vaccines. In producing the vaccines, live viruses are subjected to the rays of the lamp to kill the active virus. The inactive virus which remains cannot cause the disease, but does produce anti-bodies when injected into a person.

Close cousins to the germicidal lamps are the ultraviolet tubes that are used to develop colors and dyes, or to bleach fabrics and waxes and other articles of commerce. Still others are invaluable in the photochemical process — the production of fertilizers or many things that without invisible ultraviolet would be prohibitively expensive to manufacture. In fact, the first production of uranium depended upon ultraviolet sun lamps.

Infrared Lamps

Among other groups of lamps that are not intended for seeing tasks are the so-called infrared or heat lamps. Their chief output is a kind of invisible light that has too long a wave length for human vision, but just the right wave length to be used for quick drying, baking lacquer on automobiles, thawing frozen articles, or the baking and cementing and gluing and warming of a multitude of manufactured articles. The kind of invisible light that infrared lamps produce will penetrate deeply into human tissue, thereby increasing circulation of the blood, alleviating pain, and giving comfort to the individual. They are used widely for brooding chicks, and even for taking photographs in the dark.

Then, in this strange group of almost unknown lamps, are those that help preserve meat and food from spoilage, or are used in modern packing houses to make possible the rapid

tenderization of meat. In the modern refrigerator there is usually a very small bluish colored bulb which develops ozone and destroys odors. The ozone and ultraviolet slow down the development of molds and delay food spoilage. Ozone lamps are also used in homes and offices to destroy stale odors. Executives use them to eliminate the odor of cigarettes and cigars during long conference sessions.

While some sun lamps produce light, their main function is to make people look and feel better. People feel better after sun bathing not only because they look better, but also because ultraviolet rays from the sun get under the skin and generate Vitamin D.

An Arabian Nights story could be written around the caesium vapor lamp, developing an invisible long-wave "light" which can be "seen" only by a special photocell, and hence is used in invisible signaling and the transmission of messages in the military services. Certain lamps are used to develop "talk" on a motion picture film, others to increase the production of eggs.

Plants must have light. But studies have shown that many plants can be grown without daylight by the use of incandescent and fluorescent lamps. No longer is the use of plants in the home limited to window areas. We can now enjoy living plants in any interior that is properly illuminated.

Scientists are experimenting with a lamp which produces sizable quantities of negative ions. The tests are spurred by new evidence that minute particles in the air, which scientists call ions, have a pronounced effect upon our health, and even our moods.

A survey of findings by scientific researchers around the world indicates that when the air is charged with positive ions, there is a noticeable increase in discomfort. This may take the form of dizziness, headache, asthma, and sinusitis. It has also been found to adversely affect rheumatism and arthritis, to cause mental depression, and to slow healing.

On the other hand, scientists find that when people or animals are subjected to air having negative ions, there is a definite improvement in comfort. Patients with hay fever, asthma, and sinusitis found relief, wounds heal more rapidly, and arthritis and rheumatism are reduced.

It is far too early to say that by producing a few negative ions illnesses or mental depression can be eliminated. But there is sufficient evidence at present to indicate beyond reasonable doubt that the ions, which are always present in our atmosphere, do play an important role in our living.

Sensitive Pollution Detector

➤ A NEW GAS detection system so sensitive that it can spot a gas when it is present as only a few "parts-per-billion" in the air has been developed here. The gases in a sample of air to be tested are chemically changed into a cloud of fine particles which is then passed through an ionization chamber where electrons are "borrowed." Identification of the gases present is based on measuring the number of electrons taken, John P. Strange, director of the project at the John T. Ryan Memorial Laboratory of the Mine Safety Appliances Company, Pittsburgh, has reported.

Analysis in Ammonia Plants

➤ In recent years a number of synthetic ammonia plants have been constructed to produce ammonia by partial oxidation of natural gas or refinery gas having a high concentration of methane.

Of extreme importance in this type of process is the measurement of the residual methane immediately after the reformers. The concentration of methane is an indication of reaction efficiency thereby enabling the operator to adjust the process when there are changes in temperature or a change in the methane content of natural or refinery gas which is being used as the raw feed stock.

Naturally the analysis of methane in the process gas after the reformers presented a serious problem since the gas stream is dirty and contains steam saturated at a high temperature and pressure.

The problem has been successfully solved however at the Mississippi River Fuel Corporation Ammonia Plant at Selma, Missouri.

There are five generators and the product gas from any of these units can be continuously analyzed by one of the two M-S-A LIRA Infra-Red Analyzers using a special sampling system constructed for this particular problem by Mine Safety Appliances Co. of Pittsburgh, one of the top producers of infra-red and other instruments.

Sampling System

The sampling system used at the Selma installation is shown in the accompanying photograph. The analyzers and sampling systems are located beneath the generators. No special protection is provided for either the analyzers or sampling system.

The sampling system (as shown in the schematic flow diagram) consists of a special sample probe mounted in a six-inch line, a stainless steel water-cooled sample conditioner with a steel release trap, filter and pressure reducer and regulator. Since the sample stream is steam saturated at 400 psig. the sample conditioner is made of welded steel. The sample is cooled by the outside water jacket and the condensate collects in the bottom of the tower. As the condensate builds up it causes the steel trap to open and the stream pressure forces the condensate out.

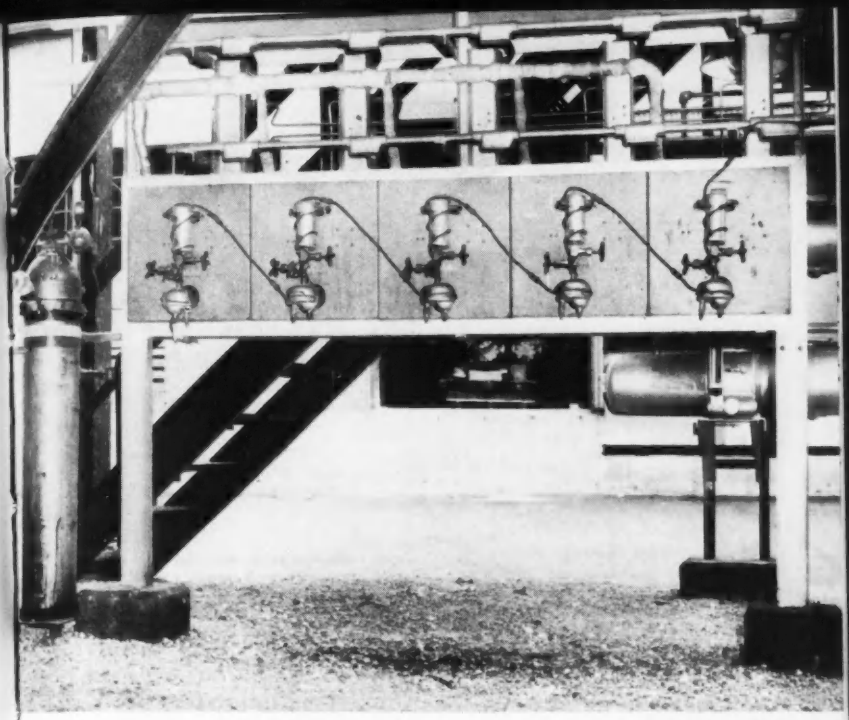
Infra-red Analyzers are also used at other points in the ammonia plant to measure carbon monoxide, carbon dioxide, etc.

Analyzer

Basically the LIRA consists of two infra-red light sources, two stainless steel cells called the sample and comparison cells, a V-shaped unit called the beam combiner, a detector cell, an amplifier and a recorder.

The infra-red light sources are small ribbons of nichrome similar to that found in domestic bread toasters. These sources are heated electrically to about 1300 F. where they emit infra-red light.

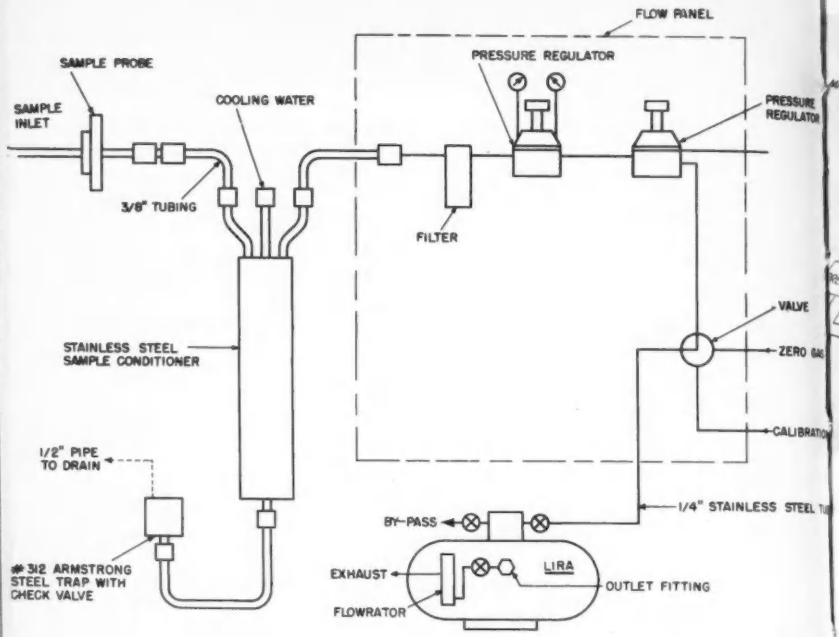
The light beams are directed into the two cells and then into the beam combiner where they are converged and are directed into the detector cell. A shutter alternately blocks each beam thereby permitting comparison of the amount of light reaching the detector through the two cells.



▶ THIS PHOTO *shows the LIRA sampling system used at the Selma, Missouri, Ammonia Plant of the Mississippi River Fuel Corporation. The analyzers and sampling systems are located immediately beneath the generators. No special protection is provided for either the analyzers or the sampling system.*

Initially the instrument is set up so that the amount of light reaching the detector through the sample cell is the same as the light reaching the detector through the comparison cell. The comparison cell is then sealed off and used as a reference. The gas which is to be analyzed is introduced into the sample cell and if it absorbs infra-red light there is an unbalance between the two beams. The amount of light reaching the detector through the sample cell is then less than the amount reaching the detector through the comparison cell because some of the light has been absorbed in the sample cell.

This unbalance between the two beams is measured by the detector in the following manner: An expansion chamber in the detector cell is filled with the gas or vapor which is to be measured and a small diaphragm is mounted above the chamber. The diaphragm is one plate of an electrical condenser and as the gas in the chamber expands or contracts it causes the diaphragm to deflect thus creating an

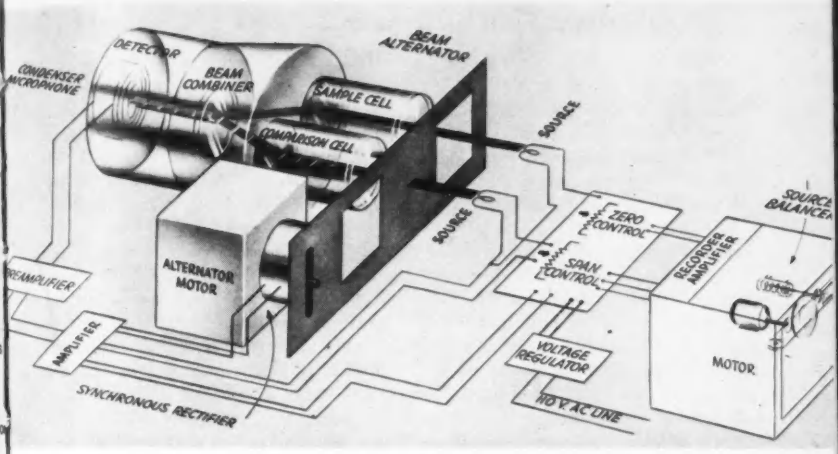


➤ THE SAMPLING SYSTEM *as shown in this schematic flow diagram consists of a special sample probe mounted in a six inch line, a stainless steel water cooled sample conditioner with a steel release trap, filter and pressure reducer and regulator. Since the sample stream is steam saturated at 400 psig. the sample conditioner is made of welded steel. The sample is cooled by the outside water jacket and the condensate collects in the bottom of the tower. As the condensate builds up it causes the steel trap to open and the stream pressure forces the condensate out.*

electrical impulse which can be amplified and fed to a recorder.

The gas in the chamber will expand when it is exposed to infra-red light of the right frequency and contract when the light is removed or lessened, therefore as long as the light beams through the sample and comparison cells are the same, there is no movement of the diaphragm when the beams are alternately blocked, for the detector always sees the same amount of light.

However, when one of the light beams is weakened by some absorption in the sample cell the diaphragm is deflected and an electrical impulse fed to the recorder. The magnitude of this impulse depends on how much of the light has been absorbed in the



➤ THIS IS A DIAGRAM *of the M-S-A LIRA, which is in use at the Selma, Missouri, Ammonia Plant of Mississippi River Fuel Corporation. The instrument is set up so that it will measure the unbalance between two streams of light, one through a comparison cell and one through a sample cell, where absorption takes place.*

sample cell, thereby making it possible to calibrate an infra-red analyzer for extremely wide or narrow ranges of gases, vapors and liquids. Moreover, since the detector responds only to infra-red light of the right frequency it is extremely selective.

Null Balance Principle

The unique null balance principle of operation has been incorporated in the basic M-S-A Infra-Red Analyzer system. In operation the output of the infra-red detector cell is electrically amplified to provide the energy necessary to operate a balancing motor which repositions a helipot used to control the voltage on one of the infra-red sources. The balancing motor also drives the recording pen and indicating pointer of the recording potentiometer. By this means not only is continuous balance achieved but also increased stability and sensitivity.

Longest Endless Belt Scheduled

➤ THE LONGEST permanent belt-type conveyor system ever built will be constructed here by Link Belt Company, Chicago.

The five and one-half mile long, 36-inch wide endless rubber belt system will connect the Lawrence, Okla., quarry with the Ada, Okla., cement mill of Ideal Cement Company, Denver, Colo.

Amorphous Silica Gels and Powders

by Elisabeth Mitchell

➤ The amorphous forms of silica are almost infinite in variety, ranging from the dense, hard, impervious mineral opal to the extremely light, porous synthetic product "aerogel."

The first synthetic silica gel was prepared over two hundred years ago by J. H. Pott as outlined in his work, *Lithogeognosia* (1746). Thomas Graham studied the formation of silica gel while laying the foundations of colloid science about ninety years ago, but no-one was interested in it for commercial application.

During World War I, new adsorbents were much in demand for gas masks. It was during the latter part of the war that silica gel was developed to the point that commercial preparation could begin.

Dr. Walter A. Patrick, now of Johns Hopkins University, developed the process for manufacture. Sulfuric acid and sodium silicate, when mixed, set up to a firm hydrogel, which is washed with water for a long time to remove the sodium sulfate. The pure hydrogel after drying and grinding results in silica gel of various granular sizes down to extremely small particle-sized powders. When prepared this way, without other chemical additions, the purity of the silica gel is extremely high — a typical purity being 99.71% silica on a dry basis.

Comparison of Natural and Synthetic Forms

What is the difference between silica gel and other silicas? For example, what are the principal differences between a manufactured silica gel and a naturally occurring silica e.g. sand?

There are very few naturally occuring sources of silica in high purity form. With few exceptions they vary in color, size, purity, and other critical characteristics. In general they occur in crystalline form and are most frequently non-porous in structure, i.e. they are found as non-adsorptive solid particles, with non uniform physical and chemical properties.

Silica gel in contrast to these natural materials is a non-crystalline product, with a tremendous internal porous structure and accompanying large surface area. It has no odor, is white in color, and does not easily react chemically. When in powder form it has a large adsorption for both water and oil. The powders are low in density, weighing as low as $\frac{1}{12}$th as much as water.

Expansion of Usage

This white amorphous powder initially had limited usage. It was mostly used for the drying of air and gases, the treatment of oil and gasoline stocks, and as a catalyst carrier.

Since then the uses have expanded into the oil, chemical, paint, plastic, rubber, packaging and allied industries.

One company marketed finely divided silica gel powders as an internal medicine, a tooth paste, and a body dusting powder.

Following World War II, as a result of concentrated research and development, a wide variety of powdered silica gels, each designed for spe-

cific applications, were gradually put on the market.

One of these applications, very recently developed, is that of an insecticide. During research conducted at U.C.L.A. by Dr. Ebeling, Dr. Tarshis and co-workers last May, 162 inert silicas and dusts were tested on dry wood termites. One of the silica gels tested proved most efficient in insecticidal power. This particular powder has a small particle size averaging 3 microns. It has a very large internal porous structure and can adsorb water up to 100% of its own weight without changing in appearance or powder characteristics.

An interesting aspect of this use as an insecticide is that it is thought by entomologists to be resistant proof. This is due to a fundamentally physical action rather than the chemical reaction of many other pesticides. The fine dust attacks the essential waxy coating which protects the body moisture of the insects and dessicates them.

Crystalline forms of silica can cause silicosis, a disease of the lungs, but no past recognized medical study or experience has shown that the amorphous non-crystalline silica gels are toxic to warm blooded animals, though they are lethal to insects.

Chem Labs To Help Steelmakers

➤ STEEL INDUSTRY executives are counting on research laboratories for a major portion of the help they will need in meeting America's ever-growing demand for their product.

The industry that today is capable of turning out 140,000,000 tons of steel per year will need a capacity of 250,000,000 tons per year in 1975, a survey of leading steel executives taken by *Steel* Magazine, Cleveland, revealed.

To achieve that capacity, the industry is relying on the research laboratory for new processes, new equipment, techniques for getting more steel out of each ton of our dwindling iron ore reserves and for a guide to better utilization of manpower.

John Botzum, Washington editor of *Steel,* told CHEMISTRY, "the feeling that laboratory-scale experiments do not apply directly to operating equipment is rapidly being disproved." More and more steel companies, it was found in the survey and talks with men slated to guide the industry into its future, are relying on the laboratory.

The magazine also posed and answered the question, "Will the steel plant of 1978 bear much of a resemblance to its 1958 counterpart?" The answer, it reported, is that the relationship will be that of "cousins — differences will be a matter of degree." For example:

Companies, plants and equipment will be bigger than they are today.

Processes like the increasingly popular oxygen converter and electric furnace will challenge the blast furnace and open hearth.

Production of "garden variety" products (routine bulk items) will be highly automated and computers will make big inroads in process control. Consequently, *Steel* predicted, electronic specialists will be in great demand.

Viruses in Life Synthesis

➤ THERE IS NEW information that suggests that the ladder of life on earth, from the nonliving to the highest types of plants and animals, now can be followed rung by rung.

The way seems open, following recent revolutionary chemical developments, to the actual laboratory synthesis of a structure having most of the properties of a living agent.

The remarkable recent progress in breaking down the barriers between molecules and organisms is described by Dr. Wendell M. Stanley, Director of the Virus Laboratory of the University of California, in the Annual Report of the Smithsonian Institution, for the year ending June 30, 1957, recently published.

The remaining essential step, he says, seems to be synthesis of one of the chemically highly complicated nucleic acids which forms an essential component of viruses and of genes, the units of heredity. This may be close at hand.

Dr. Stanley is the chemist who, more than 20 years ago, demonstrated the true nature of filterable viruses, the still somewhat mysterious particles, among which are the agents of some of the most devastating diseases.

Highlights of the Report

The ladder of life, as pictured in the report, is essentially as follows:

Nucleic acids, major constituents of genes, the units of heredity.

Viruses, which incorporate nucleic acids and which under appropriate conditions not only can multiply but which can mutate into new forms.

Single-celled living things, such as bacteria and protozoa.

Multi-celled organisms comprising all higher forms of life.

The barriers between these have broken down one after another in the last few years. This progress seems to have culminated very recently, Dr. Stanley says, in a demonstration by Dr. H. Fraenkel-Conrat at the University of California that one of the nucleic acids may have all the essential properties of a gene or of a group of genes. Already proteins, building stones of life, have been produced from amino acids.

Discovery of Viruses

This possible road to life synthesis, Dr. Stanley points out, may be considered to have started with the discovery of viruses as the agents of certain plant diseases about 50 years ago.

They were sub-microscopic particles which, it was demonstrated, possessed two of the distinctive properties of living organisms. They could multiply. They could undergo hereditary changes. They could multiply, however, only in one environment — a living cell. Moreover, it appeared that a specific virus many times could multiply only in a specific kind of cell.

It soon became apparent that quite similar particles were responsible for many animal diseases.

There was, however, an enormous gap between any virus and any known living thing. The smallest bacterium, for example, was ten times the size of any of the first-known viruses, which were comparable in dimensions to large molecules. Any actual cell contained many molecules. Dr. Stanley himself demonstrated that

viruses could be crystallized like various inorganic chemical preparations.

Recent Developments

Within the last few years, he says, the size barrier has broken down entirely with the finding of larger and larger viruses. Now the gap between virus and single-cell organism is completely filled. There is even some overlapping. With present techniques an enormous number of new viruses have been discovered. Now discovery of one or more is almost a weekly event. Relatively few are agents of any demonstrable disease. Human beings may contain many viruses which continue to multiply generation after generation without seeming to do any harm.

Perhaps of even more significance than filling the size gap have been demonstrations of the extreme mutability of the particles. New forms are likely to be produced at any time and continue in hereditary lines. This possibility for change, responsible for all evolution, is considered a unique character of life.

Thus an almost unbroken series of bonds now exists between the undoubtedly living and crystallizable "nonliving." The recent finding that one of the nucleic acids itself has the capacity for both heredity transmission and change nearly completes the connection.

The remaining step seems to be the synthesis of this nucleic acid out of its constituent parts, the purines, pyrimidines, and sugar molecules, just as proteins have been synthesized from amino acids. It would be one of the outstanding events in all history.

Openings for Research

An extremely fruitful field now opening, Dr. Stanley points out, is that of the possible relation between viruses and human cancer. The fact that certain of these "half-alive" particles are the agents of various animal cancers now is recognized. By preparations of the virus these can be transferred from one individual to another. But malignant neoplasms of man have generally been assumed to be non-transmissible.

But here, the report points out, the increasing host of "silent viruses" found in man, with their extreme capacity for mutations into virulent forms, offer a great area of research.

Interplanetary Dust Heavier

➤ INTERPLANETARY DUST that would bombard the skin of an earth satellite or space ship is much thicker than has previously been thought.

The dust blanket of meteor particles immediately above the earth's atmosphere may be as dense as 200,000 specks each cubic mile, Dr. David B. Beard of Lockheed Missile Systems Division and the University of California reported at the American Astronautical Society meeting.

The dust could cause pitting and erosion to the outer skin of a space vehicle, raising the internal temperature and impairing its performance. The particles have a velocity of about seven miles a second, he said, so up to 20,000 will hit each square inch during a year.

However, the skin would probably not be punctured except from a hit by larger-sized particles, which occur much less frequently.

➤ HEAT FROM 6000° *F. oxygen acetylene torch eats through one-eighth inch copper plate but fails to penetrate the block of fibrous titanate. Composed of small fibers which block heat penetration by scattering infrared rays, the new material may prove suitable for many space age insulating problems where space and weight are critical.*

Space Age Insulator

➤ DIFFICULT SPACE-AGE insulating problems may be solved by a white fibrous material, that combines light weight with excellent resistance to heat.

Called fibrous potassium titanate, the new product is composed of a compact mass of crystalline fibers which due to their fineness give it a talc-like feel. Because of the small diameter (less than 1/25,000 of an inch) and high reflectance of the fibers, the new insulating material blocks heat penetration by scattering incoming infrared rays.

The product was developed by the Du Pont Company, based on fundamental research on new forms of inorganic materials by their central research department. It is now produced on a semi-works scale, but decision to manufacture commercial quantities

must await evaluation studies now in progress.

Fibrous potassium titanate appears best suited for insulating applications where space and weight are critical, according to Dr. J. B. Sutton, specialty products sales manager for the company's pigments department. In the 1300° to 2100° F. range, it is about twice as effective on a volume basis as any known insulating material, he said.

As a thermal insulator at high temperatures, fibrous potassium titanate may offer construction advantages for rockets and missiles, aircraft and atomic-powered vehicles. Suggested but as yet untried uses include insulation for missile nose cones and rocket combustion chambers.

Other suggested applications include use for electrical and acoustical insulation, reflective shielding for heating units and ovens, gaskets and packing, filters, fire blankets and protective clothing, high temperature paints or coatings, high temperature cement and caulking, paper filler, and plastic reinforcement.

Blocks, which can be formed into any desired shape while wet, show exceptional dimensional stability upon prolonged exposure to heating. After six days aging at 1900° F., blocks have shown no dimensional change. Fibrous potassium titanate has almost four times the insulating value of commercial firebrick at comparable temperatures with one-twelfth the weight.

One of the unusual advantages of the product is ease of fabrication. Presently available forms include loose fibers, loose fill, blocks of varying densities, mats of various thicknesses, and "lumps." Also available is a trowelable material which, when combined with water, can be spread onto almost any irregular surface like mortar.

British "Limeys" Could Be "Beanies"

➤ BRITISH "LIMEYS," or sailors, might have been known as "beanies" instead.

Instead of avoiding scurvy by sucking limes to obtain vitamin C, sailors of the Royal Navy could have obtained the sunshine vitamin by eating sprouted beans, Dr. Albert A. Dietz of the Toledo (Ohio) Hospital Institute of Medical Research has reported to the American Chemical Society.

Many grain-type animal feeds are considerably improved nutritionally by allowing them to germinate, or sprout, before using them. Dr. Dietz questions whether vitamins, proteins and enzymes developed in the foods during sprouting would be destroyed by refining the cereal foods for human consumption. He has found that laboratory studies on animals show sprouted feeds to be more nutritional than the same grains, but not germinated.

Oats and barley showed the greatest effects from being allowed to sprout before being used as feeds. Germination had smaller effects on corn and wheat, and frequently the sprouted grain did not support animal nutrition as well as ungerminated ones.

His studies were based only on one method of testing nutritional values, and Dr. Dietz does not necessarily advocate only germinated cereal in the diet.

Radioactive Waste Problem

➤ THIS NUCLEAR WORLD is becoming more like a crowded restaurant with bustling waiters shouting warnings of "hot stuff."

If a tray is dropped, some one is sure to get burned.

As more nuclear reactors go into operation and more laboratories handle radioactive materials, the danger of what might be called "nuclear accidents," increases.

Already, there have been several mishaps at the nuclear installations in Oak Ridge, Tenn.; Chalk River, Canada; Arco, Idaho; and Calder Hall, England. All have produced some environmental contamination.

One of the most urgent problems is that of processing and disposing of radioactive waste. The misuse of disposal techniques or the misplacement of wastes could easily bring radiation injury or worse to nuclear workers, and to others miles away from the disposal area. Yet, substantial research into the disposal problem is a rarity. One of the few extensive programs is in progress at the Hanford Plant, Richland, Wash.

Dr. J. J. Davis of Hanford's biology operations has found that the danger of contamination by radioactive isotopes is a fantastic complexity.

At Hanford, low activity wastes are discharged into the Columbia River and carried over 300 miles to the Pacific Ocean. Much of the radioactivity becomes concentrated in the fish and plants of the river. This contamination is far below the presently accepted hazard to living organisms.

In their natural life cycles, the river organisms feed on one another, spreading the contamination around. Insect larva, upon reaching their adult stages, fly long distances from the river, carrying the radioactivity with them. Birds eat some of the insects and take the contamination with them on long migrations.

The river, about 30 miles downstream of the waste discharge points, is tapped for irrigation. Radioactivity in minute amounts is found in field crops, beef, and milk.

Dr. Davis found that gaseous waste, consisting mostly of radioactive iodine, settles on the foliage on the 600-square-mile Hanford Reservation. Herbivorous animals, such as rabbits, eat the foliage and absorb the iodine into their thyroid glands. Coyotes eat the contaminated rabbits.

The rabbits serve as excellent contamination detectors, Dr. Davis said. They nibble on foliage all over the reservation, and a measure of their radioactivity is an accurate measure of contamination in the area.

The most active waste isotopes are stored in underground tanks. But this seemingly foolproof measure may not be the answer. Some scientists believe that wastes may react in such a way as to form gases that could burst the tanks, and radioactivity could seep into underground streams.

Various other disposal techniques are being considered. One of them is to encase the waste in concrete blocks and sink them in the oceans. It has already been tried by the English. However, other nations have protested that the gases formed could explode out of the cases and that some chemical reactions inside the cases could make them brittle.

Massive underground salt forma-

tions show some promise as containers. Dumping into the sea is under consideration. It may be possible to inactivate the radioactivity by passing the waste through ion exchange columns. At Oak Ridge, some work is being done on the fusion of waste into insoluble clay bricks for deep burial. It is believed that part of the U. S. rocket program is being carried out with the idea of sending some radioactive wastes into outer space.

As massive as all of this appears, very little actual work is being done, except at Hanford, Oak Ridge and a few other places. In fact, a recent survey of radioisotope users came up with the dismaying news that 41% of them are dumping their wastes into sewers.

Extract Ocean Metals Economically

▶ How to extract the metals contained in the billions of tons of nodules on the ocean's floor is being studied by two University of California engineers.

Nodules are small, brown-black stones, usually less than six inches in diameter, that dot some 40,000,000 square miles of the floors of the world's oceans. Millions of years ago they began growing around bits of volcanic glass, pumice, clay and such oddities as sharks' teeth.

It is believed the nodules could be recovered with present technology using such equipment as a huge dredge resembling a vacuum cleaner, artificial light sources and television cameras.

The problem Dr. Herbert E. Hawkes and John Mero are studying is how to process the nodules and separate them into metals at competitive prices.

Mining nodules could be especially important in giving the United States a source of the important mineral, manganese. Almost all manganese used in the United States is imported.

Recently scientists at the University of California's Scripps Institution of Oceanography, La Jolla, discovered and explored a huge store of nodules in relatively shallow waters off the French-owned Tuamotu Islands in the South Pacific.

Nodules recovered from this area during Scripp's Downwind Expedition contained approximately 25% manganese, 15% iron, and less amounts of nickel, copper and cobalt, as well as a number of rare earth metals.

A new mineral processing technique for nodule mining is needed, since no suitable processing method exists.

Studies of nodule distribution so far suggest that "vacuuming" one square mile of ocean bottom in a good location would yield about 6,000 tons of manganese, 4,000 tons of iron, and 125 tons each of nickel, copper and cobalt. Converted to dollars and cents, this would amount at present values to about $750,000 worth of manganese ore, $40,000 worth of iron ore, $180,000 worth of nickel, $60,000 worth of copper and $500,000 worth of cobalt.

Since all the nodules lie in areas beyond the three-mile limit, a legal claim is not recognized and competition could become intense.

Tantalum Carbide Filaments

Another Science Talent Search Project Report

by NEIL LOGAN NININGER*

➤ DURING THE SUMMER of 1957, I worked at the Radiation Laboratory of the University of California. I worked eight hours a day, five days a week for most of the summer. During this time I worked on the problems of how to make tantalum carbide filaments which would not develop localized hot spots and burn out prematurely. These TaC filaments, which, theoretically, should burn at 3800°C for short periods of time, were to be used in the Radiation Laboratory mass spectographs.

The mass spectrograph's sample is placed on a filament (usually tungsten) and ionized by thermal agitation. The ions thus produced are accelerated through the mass spectrograph and analyzed according to mass and abundance. However, a metallurgical process introduces potassium into the tungsten filaments in amounts which are undetectable to the analytical chemist. This small impurity, which is easily ionized, floods the mass spectrograph with potassium polymers of K_2 to K_{15}, a highly undesirable situation.

Thus, the advantage of the tantalum carbide filament is that it can be purified for use in the mass spectrograph by heating it to about 3800°C to vaporize and driving off all impurities. The tungsten filaments can be heated to about 3200°C, a temperature at which the potassium is only slowly driven off.

Experimental Techniques

In the process which I used to produce the TaC filaments, a tantalum filament is heated in an atmosphere of methane at 2 to 40 mm of Hg, at a temperature varying from 800°C to 2300°C. The methane decomposes on the filament, evolving H_2, and leaves the carbon to diffuse into the filament. Ta_2C is first produced, and, after more carbon has penetrated the filament, TaC is formed. The rate of reaction is varied directly with the temperature and pressure of the methane. For high reaction rates, I used methane pressure of the order of 40 mm of Hg and temperatures of the order of 2300°C.

The filament cross section is .001″ x .030″ and is mounted on Kovar supports in a vacuum chamber.

The filament is placed in the system so that temperature measurements can be made through the quartz window with a pyrometer. The system is roughed-out with a roughing pump. Methane is flushed into the system and pumped out again

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* *Neil Nininger was among the top five winners of the 17th Annual Science Talent Search for the Westinghouse scholarships and awards. He won the Westinghouse $3000 scholarship and was offered a Chicago Alumni Scholarship of $1050 a year, both of which he accepted. He has just graduated from the Tamalpais High School in Mill Valley, Calif., and is now attending the University of Chicago with the intention of majoring in physics. Information about the STS may be obtained from Science Service, 1719 N St., N.W., Washington 6, D. C.*

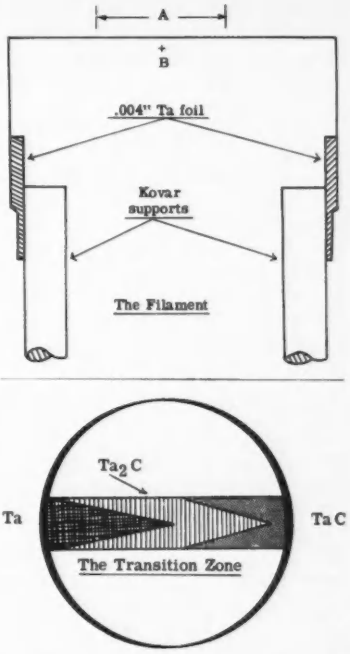
several times to insure a high purity of gas. Then the methane is set at a given pressure with the manometer, and the filament is turned on to a given temperature.

After the filament of TaC is formed, the system is evacuated and the filament is heated to determine the burn-out temperature, as measured by the pyrometer. All temperatures referred to are not corrected for emissivity.

Experimental Results

TaC, Ta_2C, and Ta all have different crystal types, and the junctions of the various phases are poor electrical connections. Consequently, hot spots develop at these junctions of high resistance, burning out the filament. Thus, the problem becomes how to produce filaments whose phase junctions are increased in area. When this is done, the total resistance across the junction is lowered.

The effect of temperature on reaction rates is such that when a filament is run at a low heat (800°C), the reaction is slowed to such an extent that the formation of the various phases can be observed. Under this condition, Ta_2C first forms in the hottest part of the filament, the region noted as "A" (Figure 1). As the Ta_2C has a higher resistivity than the TA metal, the "A" region becomes hotter and begins to extend itself over the length of the filament. At the same time, TaC forms in the hottest part of the "A" region, at "B". The TaC formed has a lower resistivity than the surrounding Ta_2C, and forms a cold spot. The cold region of TaC extends itself along the filament, towards the Ta-Ta_2C junction. In a short time, the TaC reaches the Ta-Ta_2C junction and a very localized transition zone is formed. The resulting transition zone (Figure 2) has a high resistivity because of the low cross-sectional area of contact, and of the poor electrical contact between different crystal types. The filaments burn out at this point.



➤ FIG. 1 *shows the tantalum carbide filament used in the experiment. Fig. 2 shows the highly resistive transition zone.*

To make the area of contact gradual, I tried extending the transition zone over a larger length of the filament by carburizing rapidly. I flashed several filaments for short periods of

time, at high temperature. This was to establish the Ta_2C crystal structure along the "table" of the filaments, and well down the "legs" (Figure 1). I then ran the filaments for long period of time at low temperatures, (800°C), to form TaC over the Ta_2C crystal structure. But the transition zones were again too localized, and the filaments burned out.

I tried the above procedure again, except that after flashing the filament I ran it for long periods of time at higher temperatures (1400°C). However, the transition zones, although pushed down to the legs, became localized again, causing the filament to burn out.

After failing in this method of attack, I reinforced the legs of the filaments ("C" in Figure 1) with .004" Ta foil strips. When the transition zones are pushed down to this reinforced region, they have a larger cross-sectional area with lower resistance. The reinforced transition zones also have higher mechanical strength, all of which enables filaments made by this last method to be used in mass spectographs.

Ribonucleic Acid Affects Early Cells

➤ RIBONUCLEIC ACID has been pinpointed as having an essential role in cell differentiation, the process by which the early embryo's look-alike cells become nerve, bone, skin and other organs.

Working with extremely small quantities of cellular material, 20 to 50 cells, taken from embryonic newt and salamander tissue, Dr. M. C. Niu of the Rockefeller Institute for Medical Research, New York, found that the presence of ribonucleic acid is critical for the formation of specialized tissues. He used cells removed from two-to-five-day-old fertilized eggs that under ordinary circumstances would become epithelial or skin tissue.

These cells have the unique characteristic of multi-potentiality: theoretically they could become nerve, bone or kidney cells. This is believed to be the first practical demonstration of their multi-potentiality.

By growing the cells in a hanging drop of saline solution that included a 97% pure extract of nucleic acid and protein taken from cow tissue, Dr. Niu was able to control cell differentiation.

If the ribonucleic acid had been obtained from the kidney, he explained, then the original unspecialized cells would develop into tubules when they were transplanted into living embryonic tissue. If the thymus gland had been the source for RNA, thymus-like cells would show up.

There is a very exact amount of ribonucleic acid necessary to control the cell differentiation activity, Dr. Niu found, either more or less will yield no results. Between 0.3 and 0.5 micrograms of RNA per hanging drop was found to be the optimum concentration.

There is direct relationship between the amount of RNA and the power of the cells to differentiate. Dr. Niu reported that with 40% of RNA removed, 12% of the differentiating activity of the tissue culture was lost.

Chemical Milling

Reprinted from Chemical News, Manufacturing Chemists' Assn., Inc.

▸ The Merlins of industry, resorting to the magic of chemistry, are slenderizing metal parts for aircraft and missiles in tanks filled with bubbling liquids.

Known as chemical milling, this magic shapes metal parts by eating away unwanted sections. Sections to be retained are masked with a material impervious to the chemical.

As a production process, it is only three years old. But its history extends back hundreds of years. The alchemists, dredging through the dust and dross of centuries in their search for gold, learned that certain chemicals will eat metals away.

Started With Aircraft

The manufacturing innovation came into being as a result of aircraft and missile makers' need for making complicated parts lighter, cheaper and quicker than they could be made by expensive machine tools. One of its basic advantages is that the chemical liquids can reach places inaccessible to machined tools.

Chemical milling has been used mostly on aluminum, the basic metal of the aircraft industry, A bath, containing caustic soda plus various additives which control the chemical reaction, shapes the part for its future aircraft role.

The aircraft and missile manufacturers were attracted to chemical milling chiefly because of its ability to eliminate unwanted weight, necessary to make their products fly faster and farther.

In one instance, 320 different parts of a supersonic jet fighter are treated to this chemical bathing with the result that the plane is 186 pounds lighter. Another company figures it saves 930 pounds per plane.

In other cases, this type of milling can achieve tolerances as fine as one ten-thousandths of an inch far easier than machined tools.

Cost is also a considerable factor. Machining 100 parts for fuselages costs one aircraft company about $126. Doing the job chemically costs them $20.

Aluminum is not the only metal that can be chemically milled. Magnesium is milled with sulphuric acid. Nitric acid and hydrochloric acid slenderize titanium and stainless steel. And magthorium, an alloy of magnesium and thorium, has been successfully milled, as has steel.

In planes of the future, harder metals will probably have to be used as speeds continue to climb. Chemical milling will probably be used, since the hardness of the metal does not affect the rate of removal as it does in machining.

Process Features Simplicity

Construction of an umbrella-like bulkhead, over seven feet in diameter, for a guided missile is a dramatic example of the simplicity of chemical milling.

The metal is first formed by conventional methods. But it's heavier than it needs to be. Machining it would be costly.

However, the part is sprayed with

synthetic rubber, then baked to toughen the rubber. The masking that covers the metal to be removed dipped into a solution containing so- is stripped away and the part is dium hydroxide.

This caustic solution eats the metal away at the rate of one-one thousandth of an inch a minute. When enough metal has been boiled away, the part is removed, rinsed and the mask stripped off. What's left is a thin bulkhead with 16 stiffening ribs.

Chemical milling is a fast growing business. But it has one definite limitation. It can't thread a hole.

√ *Chemistry Quiz* √

Directions: Mark within the parentheses corresponding to the answer you think is *most nearly correct*. Answers are on page 42.

1. Which of the following is *not* an instrument which converts one form of energy into another?
   ( ) 1. thermopile
   ( ) 2. thermopleion
   ( ) 3. transducer
   ( ) 4. transistor

2. "A metal, almost as strong as steel, but lighter, resistant to corrosion and with a melting point of 3,350°F, used in building atomic ovens." This metal is
   ( ) 1. molybdenum
   ( ) 2. tantalum
   ( ) 3. titanium
   ( ) 4. zirconium

3. "This year's meeting will feature an unusually wide field of subject matter: plasticity studies of metals, flow phenomena encountered in geologic studies, hypoelasticity, fracture of visco-elastic liquids, and determination of dispersion structure by viscometry." To which of the following societies did this meeting notice belong?
   ( ) 1. American Chemical Society
   ( ) 2. American Geological Society
   ( ) 3. Society of Petroleum Engineers
   ( ) 4. Society of Rheologists

4. The first successful separation of rare earth elements as free ions, reported in 1955, made use of what method?
   ( ) 1. chromatography
   ( ) 2. ion exchange resins
   ( ) 3. magnetic centrifuging
   ( ) 4. successive precipitation

5. A special type of temperature-sensing element which can transmit a strong signal from a very tiny temperature change is a
   ( ) 1. thermion
   ( ) 2. thermistor
   ( ) 3. thermocouple
   ( ) 4. thermophile

Complete copies (with answers and norms) of many previous Science Talent Search examinations are available at 10c each from Science Service, 1719 N St., N.W., Washington 6, D. C.

Radiation As Food Preserver

➤ EXTREMELY penetrating radiations are being tested for their ability to preserve fruits, meats, and vegetables economically and for long periods.

The objects of the work are to supply combat troops with normal wholesome meals more easily and to cut the costs of storage, especially refrigeration. These radiation preservation methods, if feasible, could also find wide civilian use.

The research is going on at the Quartermaster Food and Container Institute for the armed forces in Chicago.

Lt. Col. George E. Danald, deputy director of the Institute's food radiation preservation division, has reported that there is no doubt that radiations help foods to keep longer.

The chief concerns of his group are the working out of optimum methods for preparing the food and the neutralization of any deleterious effects. There is no danger whatever from radioactive contamination of the treated food.

Sometimes, radiation causes an off-flavor which has been described as either slightly burnt or caramel. It is not a bad flavor, just a different one.

Some vitamins and other nutritional factors may be knocked out of the food, but could be supplemented by pills or additions to the food. A complete study is being done on 21 basic foods for possible harmful chemical changes. So far, none has been found.

Food is irradiated in four general doses by either electrons or gamma rays. Gamma rays arise from the atomic nucleus and electrons, negatively charged electrical particles, come from the outer part of the atom.

A few thousand rads (a measure of radiation absorbed in tissues) inhibit sprouting in plants such as potatoes and onions.

A few tens of thousands of rads kill grain insects and meat parasites and also destroy their eggs.

From 100,000 to 1,000,000 rads kill most microbes in meats, fruits, and vegetables, and extend storage time for several weeks.

Doses over 1,000,000 rads kill all microbes and extend storage for much longer periods of time. A special problem exists in the storage of food, however; certain enzymes in the tissues tend to soften the food after a few months. The enzymes are destroyed by a heat treatment known as blanching.

Work has begun on combination treatments of radiation antibiotics, heats, and other methods. These combinations might have a synergistic effect on food preservation. This means the combinations might be more effective than the sums of their parts.

Liquid Fluorine Production

➤ THE FULL-SCALE production of liquid fluorine, a high energy oxidizer for rocket fuels, at its new facilities in Metropolis, Ill., was announced on November 4, by Allied Chemical's General Chemical Division.

The start-up of fluorine facilities at the multi-million dollar iranium hexaflurode plant is the initial step in preparing for production of UF6 for the Atomic Energy Program early in 1959.

For The Home Lab

Citric Acid From Lemons

by Burton L. Hawk

➤ Citric acid, the "fruit acid," is widely distributed in nature and is present in almost all fruits with the exception of cherries and plums. It has a pleasant sour taste and for that reason is used to supply the "tart" tang in beverages and candies. Perhaps you have noticed it listed as one of the ingredients in hard candies or soft drinks, especially lemon or lime flavored items.

Lemon juice contains about 5 to 8% of citric acid and we will use this as our source. Remember, it will take 100 parts of lemon to yield 5 parts of acid so you will need the juice of several lemons. Squeeze the lemons thoroughly and dump the juice, pulp and seeds into a large beaker. Heat and stir for a few minutes to extract as much juice as possible from the pulp, then filter. If you find the filtering process is too slow, pour the juice through a wire strainer first to remove the pulp and seeds and follow this with conventional filtering.

Neutralization and Precipitation

Now that we have a clear juice, the next step is neutralization with calcium carbonate to obtain calcium citrate. Perhaps the easiest way to do this is to add the carbonate (as precipitated chalk) until effervescence ceases. Add in small quantities, stirring after each addition. Finally, when no further reaction occurs you may consider the neutralization complete. The insoluble calcium citrate will settle out as a precipitate.

Filter off the precipitate. Carefully scrape it off the filter paper and into a beaker. Add water and stir. To obtain the acid, react the citrate with sulfuric acid. Add dilute sulfuric acid to the dispersed citrate and stir. The amount of acid is not too critical; you must use your own judgment, as the quantity to be added will depend on the quantity of calcium citrate you must convert.

The precipitate formed on adding sulfuric acid is calcium sulfate; the citric acid remains in solution. Filter off the calcium sulfate and evaporate the filtrate to obtain crystals of citric acid. Or, you may allow the filtrate to stand in a warm place until the crystals form.

Reactions and Tests

If you have succeeded in preparing a sufficient quantity of citric acid, you may investigate its properties by applying some of the following reactions.

Place a few crystals of citric acid in a dry test tube. Apply heat, gradually at first, and continue until the compound is liquid. Smell cautiously at the mouth of the tube. Note the irritating, sour odor. Aconitic acid is formed at first, and this, upon continued heating is converted to itaconic acid.

Add a crystal or two of citric acid to 1 cc. concentrated sulfuric acid in a test tube. Apply heat. The mixture turns yellow and carbon dioxide and monoxide are evolved accompanied

by the formation of acetonedicarboxylic acid. Continue heating for one minute. After cooling, add a few cc. of water and make alkaline by the addition of sodium hydroxide solution. Next add two cc. of sodium nitroprusside solution. An intense red coloration forms. This is a sensitive test for citric acid.

Compounds of Citric Acid

If you neutralize a solution of citric acid with magnesia, you will obtain magnesium citrate, which is the popular laxative known as "citrate of magnesia." This compound is actually the dibasic citrate of magnesium obtaining by dissolving the normal citrate in citric acid or alkali citrates.

Ferric ammonium citrate is sensitive to light and finds use in preparing blueprints. To prepare it, *exactly* neutralize a solution of citric acid with ammonia. You will obtain a solution of ammonium citrate. In a test tube or small beaker place 5 cc. of ferric chloride solution. Add the ammonium citrate, just prepared, to this until a clear green color is formed. This is ferric ammonium citrate solution. To demonstrate its action, moisten a piece of paper thoroughly with it and allow it to dry in the dark. Now cut out a design from a thick piece of paper. Place this on top of the citrate-treated paper and expose to bright sunlight for about ten minutes. Then quickly place the citrate paper in a solution of potassium ferricyanide. Observe your "blueprint."

Prepare a heavy milk of lime suspension an add a portion of it to a solution of citric acid. Calcium citrate is precipitated. Shake the solution and filter off the precipitate. Heat the filtrate to boiling. Note a precipitate is again formed. As you will probably deduce, this indicates that calcium citrate is more soluble in cold water than in hot. Or does it?

The substance produced by boiling is a tricalcium citrate, and this would indicate that . . . well, it must indicate something!

Citric acid is also produced from glucose, sugars, or molasses by fermentation. Selected molds and fungi are used along with various nutrient materials.

In addition to its use in beverages and candies, citric acid is used in the manufacture of alkyd resins, plasticizers and foam inhibitors. It plays a role in electroplating, dyeing operations, in special inks and in analytical chemistry.

Synthetic Diamond Prices Drop

➤ The gap between the price of synthetic diamonds and the price of nature's own industrial diamonds is rapidly closing, the world's only significant producer of man-made diamonds told CHEMISTRY.

General Electric Company's disclosure that man-made industrials the size of sand grains are selling for just 70% of their initial price one year ago indicates that the synthetic cutting stones now are firmly entrenched in America's tool industry where they are used to sharpen new ultra-hard cemented carbide tools and to maintain existing tools in good condition.

General Electric Company sells synthetic diamonds for industrial cut-

ting purposes for $2.96 per carat today, whereas the first bulk sales 10 months ago brought $4.25 per carat.

Although the price tag has been lowered, the synthetics still sell for a little more than natural stones. The tool industry's reason for accepting General Electric's diamonds even at the higher price was explained recently by Dr. H. Tracy Hall, director of research, Brigham Young University, Provo, Utah, in a review of high pressure research in the journal *Science* (Aug. 29).

Dr. Hall pointed out that synthetics sell in spite of their slightly higher price because "extensive tests have shown that the grinding efficiency of the man-made diamonds exceeds that of natural diamonds by 35%."

Officials of General Electric's metallurgical products department, Detroit, emphasized that the efficiency figure stated by Dr. Hall is "only an average and applicable only to the grinding of cemented carbide tools." They told Science Service actual tests place a synthetic diamond grinding wheel's wear as "at least 15% and up to 75%" better than the wear characteristics of a grinding wheel impregnated with natural diamonds.

There is a simple explanation for this difference.

"Man-made diamond crystals are rough and blocky," they said, "whereas natural diamonds are smooth; therefore the manufactured variety stays bonded to the grinding wheel longer, cuts more freely and requires 20% to 35% less power in wheel operation."

Because of the difference in crystal shapes, General Electric officials pointed out, the rough synthetic will stay lodged in the grinding wheel long after wearing has caused the smooth natural diamonds to "pop out."

Radioactive Pine Trees Felled, Examined

➤ "HOT" TREES may help the tire and cellophane industries toward greater production efficiency and lowered costs.

Using ordinary hypodermic syringes, scientists injected radioactive carbon, C-14, into two-year-old pine trees for one of the first controlled experiments in the study of cellulose growth in living trees.

First results indicate that there is a strong possibility for higher future yields of cellulose per tree plus improved quality for the large cellulose consumers, Dr. R. L. Mitchell, manager of the Rayonier Eastern Research division, Whippany, N. J., has reported. Rayonier scientists have completed the dissection of one of the "hot" trees and have studies already underway using the various tagged components from bark, lignin, cellulose and the hemi-celluloses.

Dr. Mitchell revealed that cellulose in quality suitable for high tenacity rayon has been isolated from the radioactive portion of the tree for further laboratory investigation, particularly in connection with rayon process mechanisms.

The work is still in the preliminary stages but it shows the feasibility of tagging cellulose as it grows in the tree has been positive, showing a substantial lay down in growth processes with only minor diffusion.

Stars Build Elements from Hydrogen

➤ ALL KNOWN chemical elements are built in the hot interiors of stars by eight nuclear processes as conditions become ripe.

Thermonuclear reactions such as man is now trying to control in the laboratory are the basis of stellar synthesis of elements.

A tie-in between the relative amounts of the various elements and the properties of nuclei supports this theory of stellar formation of matter, Drs. Margaret and Geoffrey Burbidge of Yerkes Observatory, Williams Bay, Wis., reported. In *Science* (Aug. 22), the husband-and-wife team outlined results of a broad-scale attack on the problem of element synthesis.

Sun's Evolution

Although the sun is about five billion years old, it must be at least a third-generation star, they concluded. Otherwise, it would be difficult to account for the variations in the elements in the solar system.

Starting from the observed element distribution, the Drs. Burbidge suggest that matter was created in as simple a form as possible. This could be as pure hydrogen, the lightest and simplest chemical element, or as fundamental particles, protons, neutrons and electrons and, possibly, their antiparticles.

The rest of the elements have been produced subsequently by physical processes according to known laws. This would be so whether the universe started suddenly or whether matter is being created continually.

When a star first condenses out of interstellar gas and dust, it goes through a period of gravitational contraction.

Eventually, when its central temperature becomes sufficiently high, it begins to obtain its energy by converting hydrogen to helium in its core. This is the hydrogen bomb reaction man has duplicated on earth in the unleashed fury of nuclear explosions.

Change of Structure

After a while, since there is no mixing between the core and outer layers, the star's composition is no longer uniform. Then its structure will change slightly so that it remains in equilibrium, and the star becomes slightly brighter.

By the time the helium core has grown to contain about 10% of its mass, the star must change its structure drastically to remain in equilibrium. At this point, its core contracts, releasing gravitational energy to supplement its energy output and heating up its interior, while the outer envelope expands greatly and cools.

In this way a star moves from the "main sequence" to become a red giant. Eventually the core becomes hot and dense enough for nuclei with charges greater than hydrogen to interact.

Catastrophic Explosion

When the star has exhausted all of its nuclear fuel, which will take about a hundred billion years for the sun, it may either undergo a gigantic catastrophic explosion as a supernova, or settle down quietly in the form of

collapsed matter as a white dwarf. It may also do both.

Besides the hydrogen- and helium-burning processes, the Drs. Burbidge reported the other processes are neutron capture, which can occur both slowly and rapidly; catalytic processes; equilibrium process; capture of alpha particles, the nuclei of helium atoms; a modifying process when the nucleus emits a proton or gamma ray, and alpha decay or fission.

Sick Plants Get Antibiotics Treatment

➤ Drugs for a wilted cabbage or a rusted wheat may hold the answer to diseases that cost the American farmer billions of dollars in lost crops.

The wilted cabbage and the rusted wheat did not get that way because of hot weather or by being left out in the rain. Fungi cause the wilt and rust diseases which, along with the root rots and blights, are among the most important diseases affecting crops.

Dr. A. E. Dimond of Connecticut Agricultural Experiment Station, New Haven, has reported that with basic research underway in the field of chemotherapy, the use of chemical compounds to fight disease in plants, there is promise that plants, like animals, may be given a "pill" that can cure disease.

Antibiotics, fungicides, growth hormones such as 2,4-D, and anti-growth compounds such as maleic hydrazide are being studied as chemotherapeutic agents for sick plants.

By discovering the biochemical pathways unique to fungi, scientists may be able to introduce substances into the plant that will cure diseases already infecting a plant, he pointed out. This would be an improvement over disease prevention methods that rely on sprays and other substances that must be used before the disease takes hold.

Some compounds — streptomycin is one — are useful against both plant and animal diseases caused by bacteria. Use of these drugs on food crops is, of course, Dr. Dimond said, strictly regulated to prevent humans receiving a harmful quantity of the antibiotic.

Chemotherapeutic substances fight plant diseases in three ways: they may kill or inactivate the disease organism inside the plant; they may neutralize toxins produced by the organism; and they may increase the plants resistance to disease. Scientists are trying to find compounds that can be tailor-made to harm the disease organism but not the plant.

"Tomorrow," Dr. Dimond said, "we may treat plants with a compound that lets them resist infection so effectively that the pathogen may no longer be able to maintain itself."

Already, purine compounds are being successfully used in the laboratory to combat virus diseases in plants. These are still too expensive to be used in the field, however.

√ Answers to CHEMISTRY QUIZ on page 36.
1, 2; 2, 4; 3, 4; 4, 1; 5, 3. √

Housefly May Explain Color Vision

▶ THE COMMON HOUSEFLY may help to explain how our eyes are able to distinguish colors.

A yellow pigment has been isolated from the eyes of houseflies, and its use in research is expected to bring forth new facts about the light-sensitive pigments that make color vision possible, Dr. J. M. Bowness, biochemist in the Biophysical Research Laboratory of the University of Pittsburgh Eye and Ear Hospital, has reported to the American Chemical Society. Dr. J. J. Wolken was co-author of the report. Such research may ultimately lead to a better understanding of color blindness.

Yellow Pigment Tie-in

A few light-sensitive pigments have been found in the human eye and in the eyes of chickens, honey bees and cattle, Dr. Bowness observes, but they have all been red, blue or purple. It has been impossible to explain the sensitivity of human beings, animals and insects to different colors (different wavelengths of light) in terms of these visual pigments.

The yellow pigment, however, ties in with the fact that insects are known to be attracted by light of considerably shorter wavelength than is visible to human beings.

New Light on Vision

"At present this yellow pigment does not seem to provide, by itself, a full explanation of how insects respond to light with very short wavelengths," Dr. Bowness warned. "However, examination of the properties of previously known visual pigments has been complicated by the fact that they can be dissolved only with the aid of detergents.

"It is likely, therefore, than an investigation of the housefly pigment, which needs no detergent to bring it into solution, will bring forth new facts concerning the chemistry of light-sensitive visual pigments in general. It is just possible, also, that a light-sensitive yellow pigment of this type might be one of the compounds postulated in some theories of color vision."

Color Absorption

Vision is thought to depend upon the presence in the eye of pigments that are changed chemically when light falls upon them.

The fact that they differ in color indicates that they absorb light of different wavelengths. It has been observed that in human beings the eye is stimulated by wavelengths ranging from 390 to 700 millimicrons (a millimicron is less than a twenty-millionth of an inch). The human eye, however, is less responsive to light near the extreme violet and red ends of the spectrum than to light in the center.

Insects are attracted by light with considerably shorter wavelengths, averaging about 360 millimicrons.

Dr. Bowness pointed out that several visual pigments have been identified, including rhodopsin, responsible for night vision, and iodopsin, thought to aid daylight color vision. But not enough have been found yet to account for the differences among

various animals or to provide a factual basis for some of the theories of color vision.

Although it is known that insects respond to light, no light-sensitive pigment has been discovered in insects until recently, when one was obtained from the honey bee. The pigment was difficult to study because it could be extracted only as part of the mixture containing other components.

A new technique was developed by Dr. Bowness to extract rhodopsin, then adapted for this experiment.

Chemical Cause of Schizophrenia

➤ SCHIZOPHRENIA may be the result of chemical immaturity of the nervous system.

Adult schizophrenics were found to have considerably less neuraminic acid, a component of the brain's gray matter, in the spinal cord fluid than do nonschizophrenics, Dr. Samuel Bogoch of the department of psychiatry, Harvard Medical School, and neurochemical research laboratory of the Massachusetts Mental Health Center, Boston, reported in the Archives of Neurology and Psychiatry (Aug.).

There have been many attempts to show some chemical cause of schizophrenia through the study of blood and urine, but there has been no definite demonstration of a chemical disorder in the central nervous system proper. This evidence opens avenues of investigation into possible chemical causes of schizophrenia.

Dr. Bogoch found that the levels of neuraminic acid in the cerebrospinal fluid of adult schizophrenics is "comparable only to values found in some children under seven years of age."

The low values in adult schizophrenic patients may indicate a form of chemical immaturity that would correlate well with clinical evidence of a failure of psychological maturity in the schizophrenic, he noted.

The exact function of neuraminic acid in the nervous system is not definitely known. It appears to play some role in the function of the "blood brain barrier," which helps maintain the special environment of the brain. Tests are now underway to determine the effect of the administration of neuraminic acid itself and of neuraminic-acid-containing substances to psychotic patients.

Office for Mineral Exploring

➤ AN OFFICE of Minerals Exploration in the Department of the Interior has been set up to provide for Federal assistance in financing exploration for new or additional mineral reserves. The primary purpose of the new program is to share with private industry the "risks involved in carrying out those exploration projects which have good potential but which normally would not be undertaken with private capital." Interest is charged on the funds provided which cannot total more than $250,000 for any one project. Congress has approved $4,000,000 for the new office's operations.

Vitamin K Role in Photosynthesis

➤ A FURTHER STEP in understanding the mystery of photosynthesis has been taken.

Vitamin K, important in human diets since it is necessary to coagulate blood, apparently also plays a vital role in plant life. It seems to be a chemical catalyst present in chloroplasts.

Norman I. Bishop, assistant professor of biochemistry at the University of Chicago's Institutes for Basic Research, has reported experiments in which he isolated chloroplasts from spinach leaves. He removed their moisture and fat-soluble chemicals and found that in solution the chloroplasts could no longer perform their complex photosynthetic reactions.

When man-made forms of vitamin K were added to the solution one important reaction was restored. The chloroplasts were able to convert water and ferric iron to hydrogen, ferrous iron and free oxygen.

The biochemist believes vitamin K may act as a "neutral corner" for hydrogen atoms that have been separated from water. The hydrogen later combines with carbon dioxide to make carbohydrates, another step in photosynthesis. Without the vitamin, Mr. Bishop explains, the hydrogen would ultimately rejoin the oxygen and form water again.

Chemists Split Reserpine Personality

➤ CHEMISTS have split the "dual personality" of the mental drug reserpine, into two modifications, one an agent for lowering blood pressure and the other a tranquilizer.

The new hypotensive agent is about as strong as reserpine in this respect but only one-twentieth as active as a tranquilizer in animal tests, Dr. H. B. MacPhillamy, chemist of Ciba Pharmaceutical Products, Inc., Summit, N. J., reported. The new tranquilizer is methyl 3-dimethylaminobenzoyl reserpate, with one-fourth the tranquilizing effect of reserpine but only one-fortieth of its hypotensive action in laboratory animals. It appears a promising, rapid-acting tranquilizer, and clinical investigation is under way. In the animal tests the tranquilizer accomplishes in hours the sedative effects that require days with reserpine, and the necessity of using larger doses is not a problem.

Antibiotics Evaluated

➤ THE EFFECTIVENESS of 13 antibiotics against the 29 deadliest bacteria known to medical scientists is currently being calculated. Dr. Sol Haberman of Baylor University Hospital, department of pathology, hopes to create charts that will be useful for physicians in selecting the best drug to use against specific diseases. He is including data on seasonal patterns, sex, and age, as well as the part of the body affected, in this drug-disease chart. Remington Rand's Univac Punched-Card Records Service facilities are being used in the computations.

Book Condensations

ELECTRONIC ENGINEER'S REFERENCE BOOK — L. E. C. Hughes, Ed., foreword by Percy Dunsheath — *Macmillan,* 1311 p., illus., $18. Brings together for eas yreference latest knowledge and techniques for engineers in industry and in development laboratories.

THE ENCYCLOPEDIA OF CHEMISTRY (Supplement) — George L. Clark, Gessner G. Hawley and William A. Hamor, Eds. — *Reinhold,* 330 p., illus., $10. Contains over 200 concise articles, will be the only volume added to the original encyclopedia.

CHOLESTEROL — David Kritchevsky — *Wiley,* 291 p., $9.75. Centralized source of pertinent material which has been dispersed in chemical and medical journals.

KINETIC THEORY OF GASES — R. D. Present — *McGraw,* 280 p., $7.75. Introductory textbook for students of physics, as well as students of chemistry and of the engineering sciences.

PHOTOCHEMICAL SECONDARY REACTIONS IN URBAN AIR — Philip A. Leighton and William A. Perkins — *Air Pollution,* Report No. 24, 213 p., paper, $6. Summarizes the important reactions such as those which occur in auto exhaust.

CHEMICAL REACTION ENGINEERING: 12th Meeting of the European Federation of Chemical Engineering, Amsterdam, 7th, 8th, and 9th May, 1957 — K. Rietema, Ed. — *Pergamon,* 200 p., graphs, $12.50.

POLYAMIDE RESINS — Don E. Floyd — *Reinhold,* Plastics Applications Series, 230 p., illus., $4.50. Giving the basic chemistry and raw materials, methods of manufacture and outlook for the future.

PHYSICO-CHEMICAL EFFECTS OF PRESSURE — S. D. Hamann — *Academic,* 246 p., illus., $8.50. For the most part concerned with changes brought about by pressures above a hundred atmospheres.

THE THRESHOLD OF SPACE: The Proceedings of the Conference on Chemical Aeronomy — M. Zelikoff, Ed. — *Pergamon,* 342 p., illus., $15. Papers by those studying aerothermochemistry.

NATURALLY OCCURRING QUINONES — R. H. Thomson — *Academic,* 302 p., illus., $9. Comprehensive account of quinone pigments which form the largest group of natural coloring matters.

TURBOJET FUNDAMENTALS — Howard E. Morgan — *McGraw-Hill,* 2d ed., 104 p., illus., $4. An introduction to theory and operating principles. Originally prepared by Douglas Aircraft for training their own personnel.

HUMAN BIOCHEMISTRY — Israel S. Kleiner and James M. Orten — *Mosby,* 5th ed., 808 p., illus., $9. For the student of medicine, dentistry and related disciplines.

MISSILE ENGINEERING HANDBOOK— C. W. Besserer — *Van Hostrand,* 600 p., illus., $14.50. Equations, formulas, graphs and tables important in weapons system analysis. Complete glossary of guided missile and space flight terms.

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